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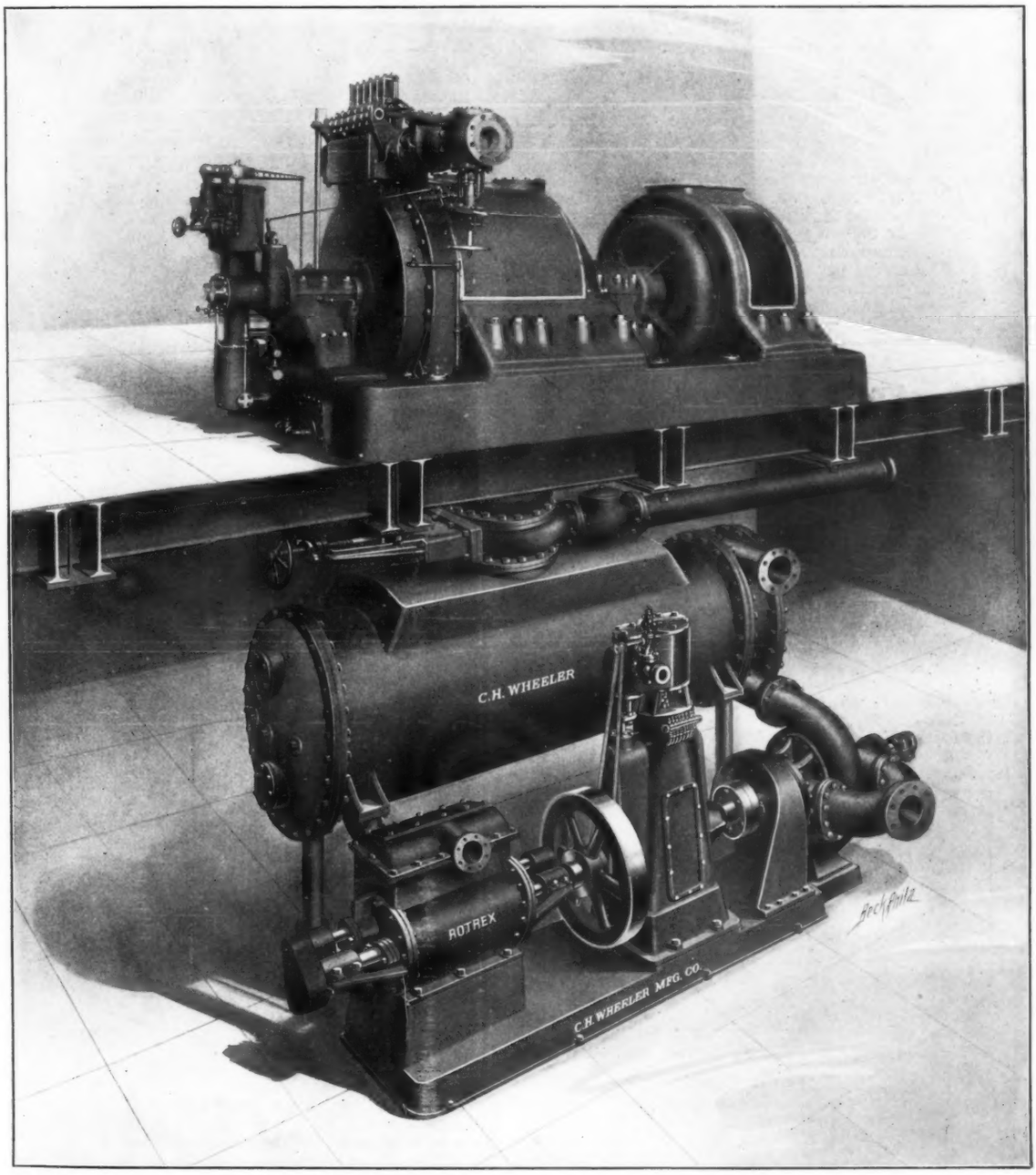

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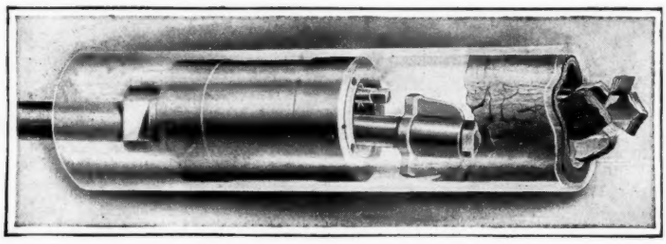

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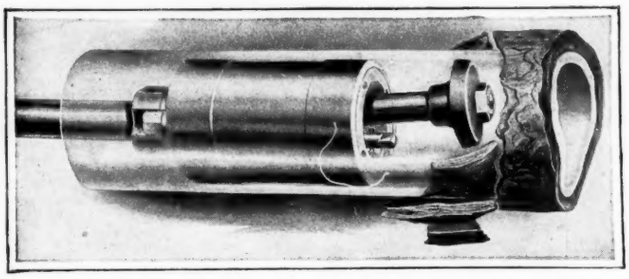

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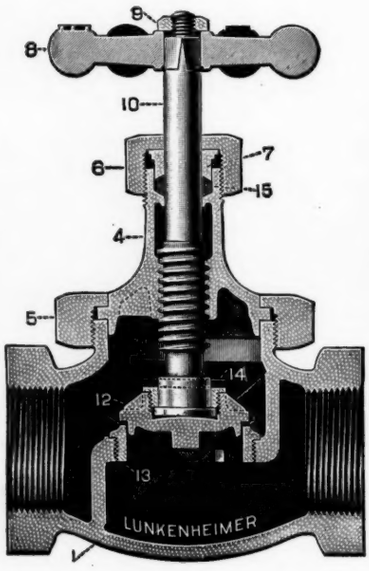

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"How"
No. 6

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¶ The way to keep the boilers in good order—in constant good order—

¶ Is to have the feed water you use analyzed, to find out what scale forming elements it contains

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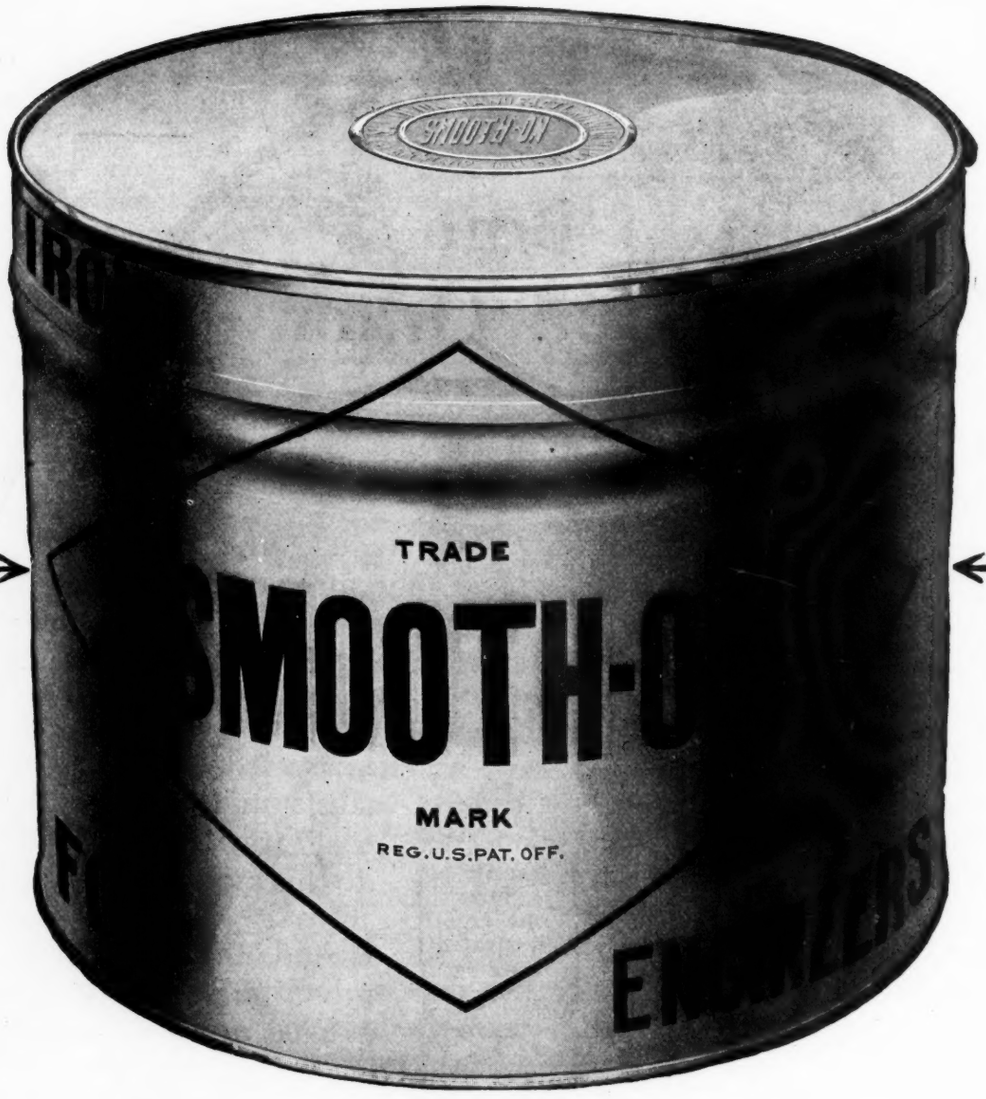

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POWER

Vol. 35 NEW YORK, JANUARY 23, 1912 No. 4

IT does not take an especially educated or experienced man to operate a small power plant so long as everything goes right. He may not operate it intelligently, and there is no question but that he will be wasteful of coal and supplies and that the equipment, no matter what condition it happened to be in when he assumed his duties, will suffer from his carelessness and ignorance. In many small plants and in some large ones the operating engineer may run things to suit himself so long as he is lucky enough to avoid accidents and succeeds in giving fairly reliable service.

If something goes wrong, the remedy which he applies is not likely to be the correct one. The engineer who started up and threw a load on a newly installed unit before the bedplate of the generator had been properly grouted to the foundation, did not realize that the magnetic forces were so unstable that they would soon cause the generator to move on the foundation.

His first intimation that something was wrong was when his hearing and his sense of smell told him that the coils of the rotor were rubbing against those of the stator. Not realizing the cause of the trouble, he used a strong but ill-advised remedy: He shifted the outboard bearing by means of setscrews provided for purposes of alignment until the rubbing ceased, but soon the trouble reappeared and he shifted the bearing a second time. The main shaft being forced out of alignment by this procedure, the crankpin box and the eccentrics soon began to heat and he was forced to shut down after the load had been transferred to the old machines.

Luckily, this man had not done any great harm, but every move he made displayed poor judgment and ignorance. His acts were based on guesses, not on good judgment backed up by knowledge. Such a man does not deserve the trust of operating a power plant.

When the competent engineer steps into his engine or boiler room, he is keenly aware of all that is taking place. He does not appear to be different from the ordinary mortal, but his perceptions and intellect are trained to detect irregularities; he is acquainted with the weaknesses of his apparatus as well as its strength; he knows the peculiarities of the load variations; he is able to burn the coal and convert heat energy into mechanical or electrical energy economically because he knows the "why" of the combustion of coal. In an emergency, his judgment is based not upon guesses and impulses but upon knowledge and experience. This makes him both resourceful and courageous.

The average owner of the small plant is accustomed to think that ordinary intelligence only is required to operate the equipment. It is as simple as boiling water in a kettle, so he thinks. Why, he himself could do all that is necessary to get up steam and start the engine in a pinch! This idea is so prevalent that owners are protected from their own judgment of the qualities of employees by a state engineer's and fireman's license law. These laws may only insure that the candidate has the average qualifications necessary to perform his duties. The employer must be made to realize that it is poor economy to hire an inexperienced man, even though it may be possible to purchase his services for less money.

The rank and file of operating engineers must also come to realize that ignorance and incompetence are not only personal defects, but also constitute an offense against their brotherhood.

Knowledge and experience open the road to results and results mean success. Knowledge, then, should be the aim of every operator. The experienced man, as well as the beginner, should constantly endeavor to progress.

The means of knowledge are close at hand. Given an inquiring mind and an ambition to use it, a few good books and engineering journals will furnish the means for great advancement. Standards will be raised and operators will have accomplished their own betterment.

Measurement of Hot Feed Water

By J. A. Knesche

The various types of instruments for measuring feed water are described. These include the venturi meter, the Pitot tube, volume determinators and weight determinators.

The suitability of each type for meeting certain conditions is also discussed.

In the power plants of industrial establishments a correct steam distribution is imperative, as competition is making it more and more necessary to know exactly and in detail the accurate charges which are to be made against the finished product. Furthermore, the cost of producing steam is now receiving more attention than formerly. Time was when the total amount of steam generated by a boiler plant was estimated from the quantity of fuel consumed. This method would be perhaps accurate enough if the efficiencies of the separate boilers were known at all times during normal operations and if the demand for steam were constant. But in many industrial plants the demand for steam is not constant. Moreover, the efficiencies of boilers do not remain the same, owing to the accumulation of scale in the tubes, etc. In determining the steam generated the feed water entering the boilers is usually measured, but when steam coming from one boiler is used by several engines and for heating and drying systems, the steam itself has to be measured.

Measurement of Hot Feed Water

Not every type of water meter is suitable to measure hot boiler-feed water. Many meters, notably those of the piston and of the disk types, will measure water correctly within 2 or 3 per cent. as long as the temperature is not over 100 degrees Fahrenheit.

One objection to measuring the water before it enters the boilers is that not all the water thus measured is converted into steam. In the normal operations of a boiler there is always a loss of feed water or steam the exact amount of which can seldom be determined. It might be argued that the quantity of water is always known before it enters the boilers during boiler trials where it is necessary to eliminate all feed-water and steam losses in order that the exact quantity of water evaporated may be known; but it should be remembered that in a boiler room the average operating conditions are very different from the conditions prevailing during a boiler trial. The water and steam losses are usually occasioned by leaks in the lines, valves or connections, while "blowing down" or by losses through the safety valves; all told, they may amount to 5 per cent. or more of the steam generated. These losses must be considered in the distribution of the steam generated in the plant.

Feed-water measuring devices may be divided into velocity, volume and weight meters. These different appliances, in order to serve the practical needs of the boiler room, must be fitted with either integrating, indicating or recording mechanisms, and in some cases with two or three of these.

Velocity Meters

The venturi meter consists of the venturi tube proper and the register connected by pressure pipes, the general arrangement being shown in Fig. 1. The water to be measured flows through the tube but not through the register, and since the tube contains no mechanism whatever, there can be no derangement of the meter tube proper due to solid particles carried along by the water. The tube is merely a pipe which tapers from each end toward the throat, which is usually lined with bronze and has a diameter of from one-third to one-half that of the ends of the meter; the total length of the tube is from eight to twelve times the end diameter. Near the inlet or upstream end and also at the throat are annular pressure chambers encircling the tube, communicating with the interior by numerous small vent holes. The cones of the tubes are usually made of cast iron, though in very large sizes they are sometimes made of plate steel, wood or even masonry. For metering liquids which will corrode iron, the tube can be made entirely of bronze or other composition metal.

When the water in the meter tube and in the pipe lines is at rest, the pressure in the throat-pressure chamber is the same as that in the upstream-pressure chamber. During the flow of water the throat pressure becomes less than the upstream pressure, the difference between these two pressures being proportional to the square of the velocity of the water. The register is affected by these two pressures and automatically translates the results into gallons which are indicated on a direct recording counter dial.

Fig. 1 shows a general view of one of the registers used with this type of meter, and in Fig. 2 are given the details of this device, illustrating the principle upon which it works, the whole arrangement being in effect a differential pressure gage. The mercury level in the mercury tube raises and lowers a float to which is secured the float stem carrying on its upper end the roller arm and the roller, the latter being held by a spring against the integrating drum. The drum is revolved (usually six times per hour) by means of the weights shown in Fig. 1; when a lever in the power mechanism is lifted by the movement of a clock, the suspended weights, acting through a series of gears, revolve the integrating drum. If water flows through the meter at a rate sufficient to raise the float so that the roller is brought to the level *A*, on the integrating drum, the roller will be in contact with the raised

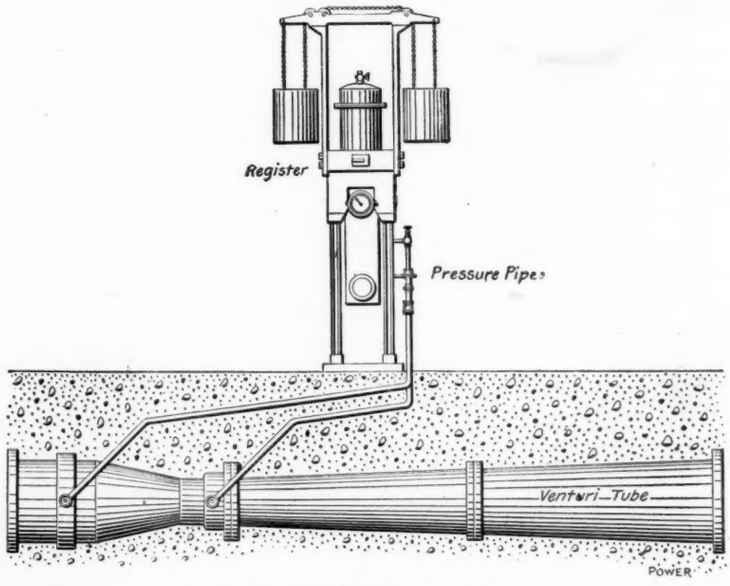


Fig. 1. Venturi Meter and Register

surface and through a lever not shown will cause a pinion driving the indicating drum counter to be unmeshed. As the integrating drum revolves in the direction indicated by the arrows the roller will move on the raised surface on the other side of the drum directly opposite the line *A B;* when it reaches the point *B* on the drum it will be pulled on the depressed surface by the spring and the pinion will mesh with the counter gearing and move the counter figures ahead, cor-

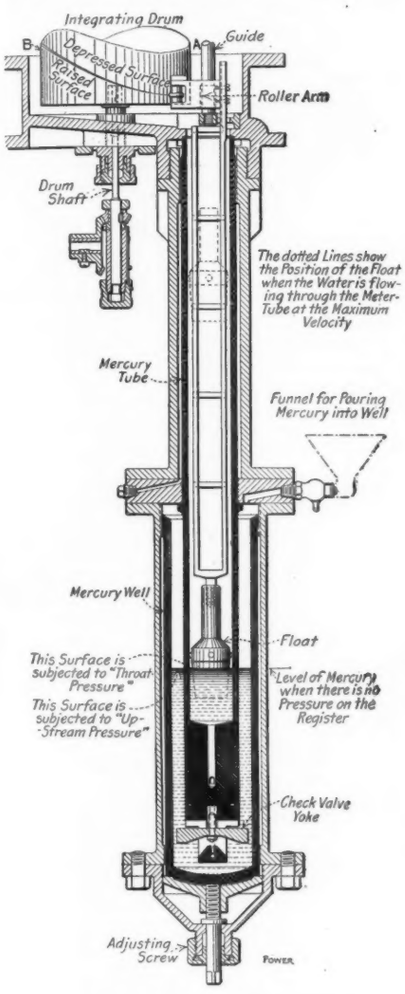

Integrating Drum
Guide
Depressed Surface
Raised Surface
Roller Arm
Drum Shaft
The dotted Lines show the Position of the Float when the Water is flowing through the Meter-Tube at the Maximum Velocity
Mercury Tube
Funnel for Pouring Mercury into Well
Mercury Well
Float
This Surface is subjected to "Throat Pressure"
Level of Mercury when there is no Pressure on the Register
This Surface is subjected to "Up-Stream Pressure"
Check Valve Yoke
Adjusting Screw
POWER

FIG. 2. DETAIL OF REGISTER

responding to a 10-minute flow of water through the meter; this amount of water corresponds to the differential pressure with the roller at *A*. Needless to say, the curve formed by the line between the raised surface and the depressed surface has been carefully calculated to give the correct counter reading.

In Fig. 3 is shown a register for use in connection with venturi meters; this has an indicator dial, a counter dial and a recording dial, and it is an instrument admirably adapted for checking accurately the flow of the feed water to the boilers.

The writer has six venturi meters with registers of the type shown in Fig. 1, and has found it necessary in the case of one installation to provide a special air chamber so as to lessen the effect of the pulsations from the boiler-feed pump. Such an air chamber is illustrated in Fig. 4.

When the venturi meters were first purchased it was decided to test the accuracy of one of the registers. For this purpose a 4-inch meter tube was connected through a pipe line to a tank fitted with a float and with an accurate water-level indicator. At the same time the constant *K* of the formula

$$v = K\sqrt{2gh}$$

was determined for a set of Pitot tubes. Many runs were made and the results were as given in the accompanying table.

TANK MEASUREMENTS, VENTURI METER REGISTER AND PITOT TUBES

Discharge in Gallons per Hour through Venturi Meter			Error of Register, Per Cent.	*H* in Pitot Tube, Inches of Water	Constant *K* for Pitot Tube Used in $v = K\sqrt{2gh}$
Tank	Register	Pitot Tubes			
572	No record	1,120	.....	0.05	0.511
805	900	1,590	+10.5	0.1	0.506
1,467	1,550	2,255	+ 5.7	0.2	0.651
2,557	2,600	3,563	+ 1.9	0.5	0.715
4,295	4,300	5,840	+ 0.001	1.35	0.735
6,050	5,975	7,720	— 1.1	2.375	0.784*
7,587	7,400	9,987	— 2.4	4.00	0.76
7,594	7,450	9,987	— 1.7	4.00	0.76
7,629	7,400	9,987	— 2.8	4.00	0.763
8,499	8,350	10,975	— 1.55	4.75	0.775
8,577	8,400	11,210	— 2.0	5.00	0.765
8,968	8,350	11,800	— 7.00†	5.5	0.76
10,821	8,350	14,100	—23.00†	8.0	0.768

*Discharge not kept constant. †Above maximum limit of register.

From this it appears that the register and the meter tube tested showed an average error, within the proper working limits of the register of 1.64 per cent. of the total water measured. This is an excellent showing and is more than sufficient for the requirements of most boiler plants.

If the flow of water is very irregular and fluctuating and if the measurements cover a short period of time only, the register shown in Fig. 2 is apt to be more inaccurate than the tests indicated. This is so because the working principle of the register is based upon the assumption that each 10 minutes' flow is constant and of a magnitude corresponding to the position on the roller on the integrating drum of the register at the time of registration. If measurements of the flow must be made covering short periods of time only, then the chart recorders, as shown in Fig. 3, will be more suitable.

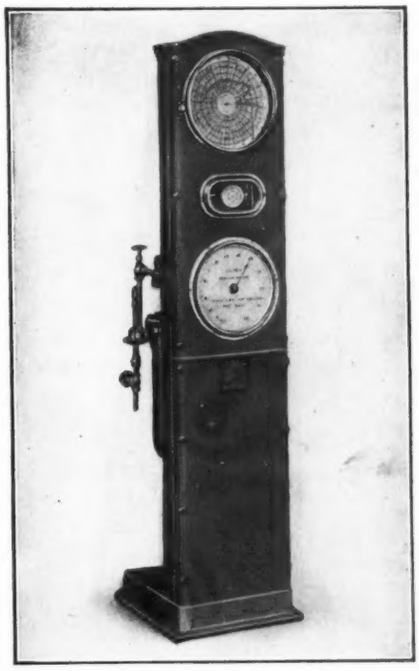


FIG. 3. INDICATING, INTEGRATING AND RECORDING INSTRUMENT

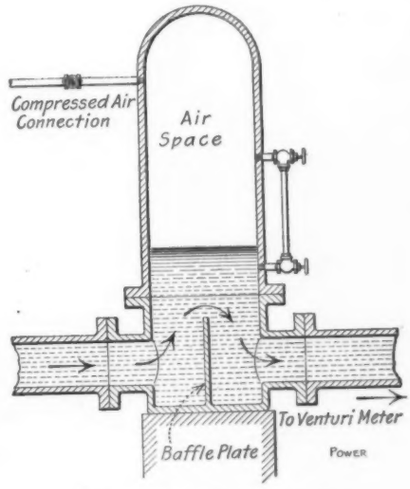


FIG. 4. AN AIR CHAMBER

THE PITOT TUBE

This method of measuring water would seem especially suited for boiler-feed water. It has practically the same advantages as the venturi meter in that solid particles can neither stop the working of the device nor impair its accuracy; any sediment which might collect in the tubes can easily be blown out.

In Fig. 5 are illustrated the essential features of the Pitot tube in position for determining the velocity of a current of water flowing along its bed with the free

surface at *B*. This instrument consists simply of a plain piece of glass tube bent 90 degrees at the lower end and placed with the open mouth *A* facing the current, while the other end extends above the surface *B*. When the water drives against the open end, a pressure results from the impact which causes the water to rise within the tube to a hight *H*, this

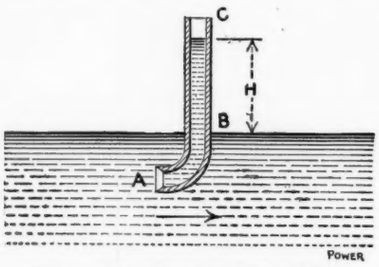


FIG. 5. ELEMENTARY PITOT TUBE

head of water being proportional to the velocity of flow. Pitot concluded that this head was simply that due to the velocity v of the current, so that

$$v^2 = 2gh,$$

where g is the acceleration due to gravity. This formula is that for falling bodies and also that for Toricelli's theorem for the velocity of water issuing from an orifice.

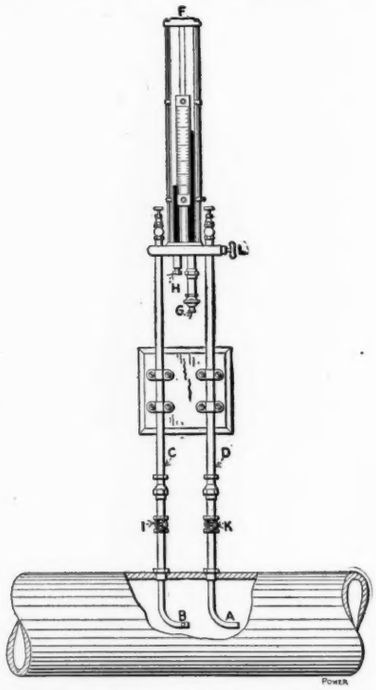


FIG. 6. INDICATING INSTRUMENT FOR PITOT TUBES

An indicating instrument for pipe lines under pressure is illustrated in Fig. 6. The difference in the water levels is shown by manometer *F*, which is practically a differential-pressure gage. This value h is used in the formula

$$v^2 = 2gh$$

and knowing the area of the pipe at the points of insertion of the Pitot tubes the quantity of water passing these points is readily computed.

It should be noted that the velocities of the water at different points of the same cross-section of a pipe are not the same. The average velocity is found at a point somewhere between 0.7 and 0.75 of the distance of the impact tip from the center of the pipe. It is impossible without much work always to get the impact tip at the point of average velocity.

From experiments it has been found that the shapes of the Pitot tubes have considerable influence on the constant K in the formula

$$v = K\sqrt{2gh}$$

One objection to the Pitot tubes described is that they are indicating instruments only. To measure constantly the flow of water in boiler-feed lines, a recording or an integrating instrument is necessary. At present no differential-recording gage is manufactured which could be used in connection with Pitot tubes for measuring the velocity of liquids. There is, however, a differential-recording gage which is used much abroad and also to some extent in this country for the continuous determination of the velocity of gases in metallurgical works, coke ovens and gas plants; also for the measurement of compressed air and for determining the velocity of air in ventilating systems. At the present time this instrument is used for the measurement of gaseous fluids only, but, with some slight modification in the installation it could, no doubt, be adapted for the measurement of liquids also.

TURBINE-WHEEL METER

Fig. 7 shows a turbine-wheel meter which, properly speaking, comes under the heading of velocity meters and is used to a considerable extent for measuring hot boiler-feed water. An excellent feature is its simplicity. Like the venturi meter and the Pitot tube, if this turbine-wheel meter is connected into the discharge line of the customary boiler-feed pump, there should be inserted in the line a large air chamber to lessen the pulsations of the pump. In the test of a 6-inch meter of this type it was found to be accurate within 0.2 of 1 per cent.

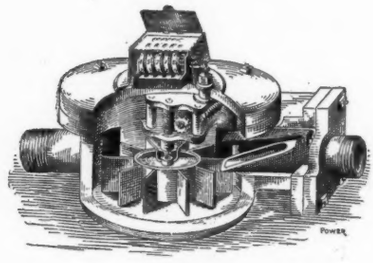


FIG. 7. TURBINE WHEEL METER

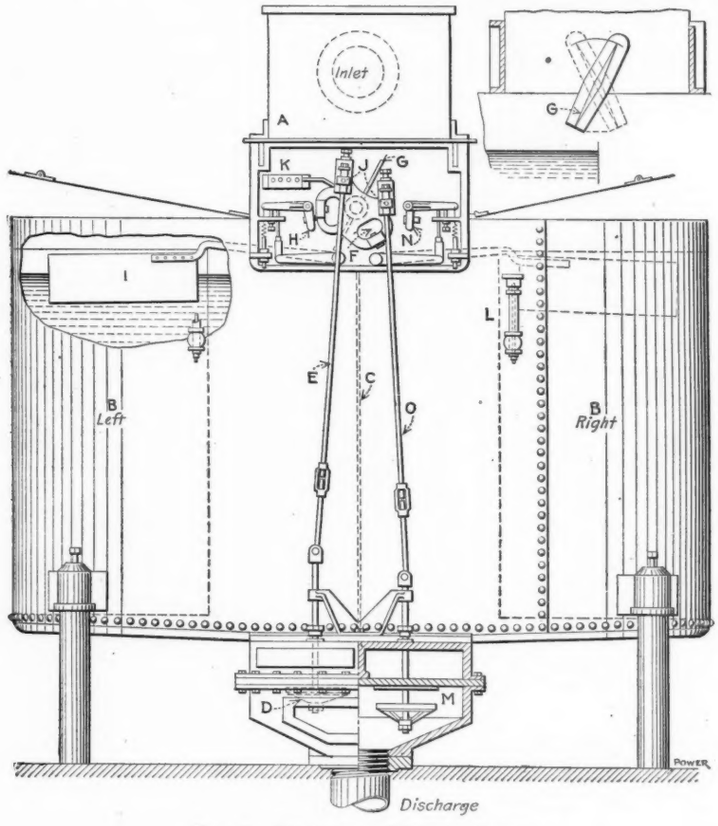


FIG. 8. HAMMOND WATER METER

Volume Determinators

Meters belonging to the class of volume determinators suitable for the measurement of hot water are in many cases of the piston type. All piston-type meters must be designed for a certain fixed range of feed-water temperature. For this reason, in plants where the feed water is sometimes pumped into the boilers cold and at other times moderately hot or near the boiling point, the piston type of meter is not so well suited.

Hammond Water Meter

The Hammond water meter for measuring water at any temperature is illustrated in Fig. 8. It consists of a receiving tank *A* and a measuring tank *B* which is divided into two compartments by the partition *C*. The liquid enters *A* and flows through a slot in the bottom to the measuring tank *B* in which are placed the discharge valves *D* and *M*, opening downward from each compartment; these discharge valves are held to their seats by the valve rods *E* and *O* attached to the wristplate *F*. The inlet valve *G* is connected to the wristplate on the same shaft.

With the inlet valve and the wristplate in the position shown and the water flowing into the left side of the measuring tank, the discharge valve *D* is held to its seat by the wristplate, which, in turn, is held by latch *H*. As the water rises in this compartment it lifts the float *I*, which causes the latch *H* to unhook and release the wristplate. The weight of water on the discharge valve *D* instantly pulls the valve down and rotates the wristplate, thus turning the inlet valve *G* so as to deflect the incoming water into the right side of tank *B*. At the same time the wristplate draws the discharge valve *M* to its seat where it is held up by latch *N* and the water now flows into the right compartment. There are springs at *J* in the heads of the valve rods which hold the discharge valves to their seats and keep them from leaking. The wristplates and the latches are provided with hook blocks similar to those on the valve gear of a Corliss engine, and are made of hardened steel. The operation of the meter is automatic and continuous, a record of the cycles of operation being tallied on a revolution counter.

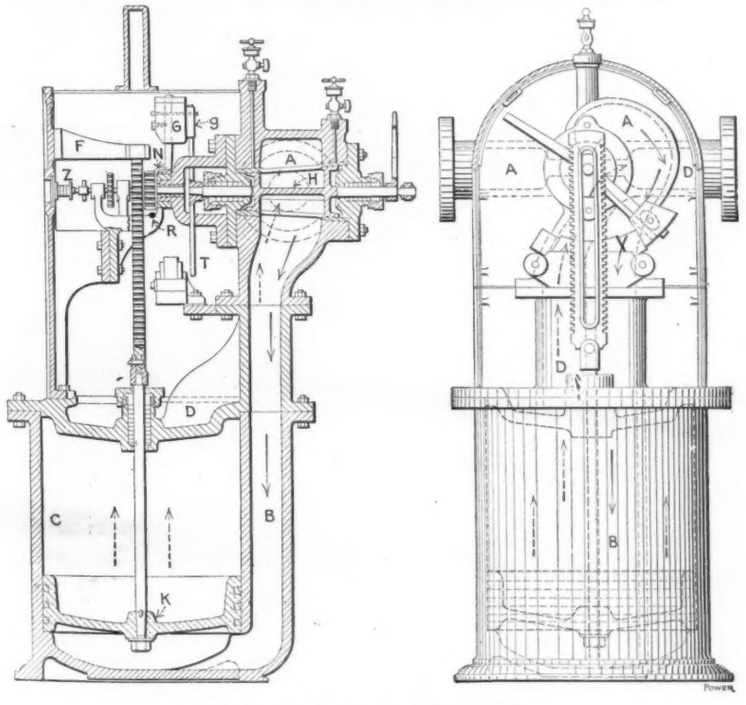


Fig. 9. Eckhardt's Water Meter

Eckhardt's Feed-water Meter

The working of this meter is illustrated in Fig. 9. The meter is placed in the feed line between the feed pump and the boilers, and the water enters and leaves through a four-way valve so arranged that there is always an unobstructed passage from the pump to one side of the piston *K* and an open passage from the other side of the piston *K* to the boilers. When the piston is at the bottom, as shown, water enters under it through the port *A B*, lifting the piston and pushing the water above it through port *D* to the boilers. The double rack which is connected to the piston rod drives the gear *N* and this is provided with a small projecting lever through which an arm carrying the weight *G* is lifted. This arm with the attached weight is raised until it falls over on the other side by reason of gravitation. During the turning over of the weight a projection engages a double lever *T* which operates the four-way valve. In this manner the discharge and entrance of the water to the meter are reversed. The piston now descends and the entire mechanism again goes through the same cycle. Through a train of gears the number of piston strokes is recorded by a counter.

In a series of 57 tests, during which the water was carefully weighed on a scale and the temperature of the feed water ranged from 80 to 140 degrees, this meter showed an average accuracy of 0.47 of 1 per cent. This high degree of accuracy is readily understood when it is remembered that practically no water can pass the piston unmeasured.

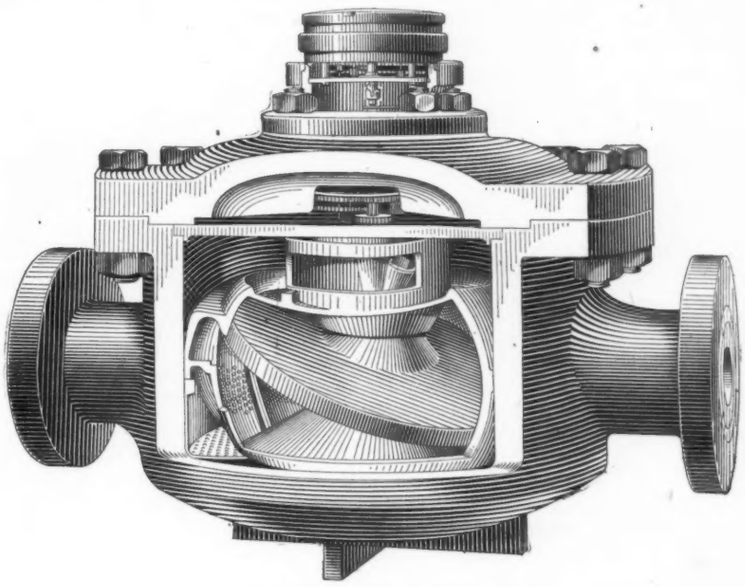


Fig. 10. Siemen's Disk Meter

Siemen's Disk Meter

The Siemen's disk meter, shown in Fig. 10, is manufactured in Germany, although used extensively in this country.

Because of its relatively small size it may be connected practically anywhere into the boiler-feed line. Every oscillating motion of the measuring device fills and empties the measuring chamber at every turn similar to the piston displacement in the piston type of meter. One advantage claimed for this meter is its certainty of operation because of the complete expansion permitted to all working parts in all directions even by quickly changing temperatures of the feed water. Another advantage is the small repair bills necessary by reason of its simple construction, and no lubrication is necessary because of the carbon compositions used in the meter.

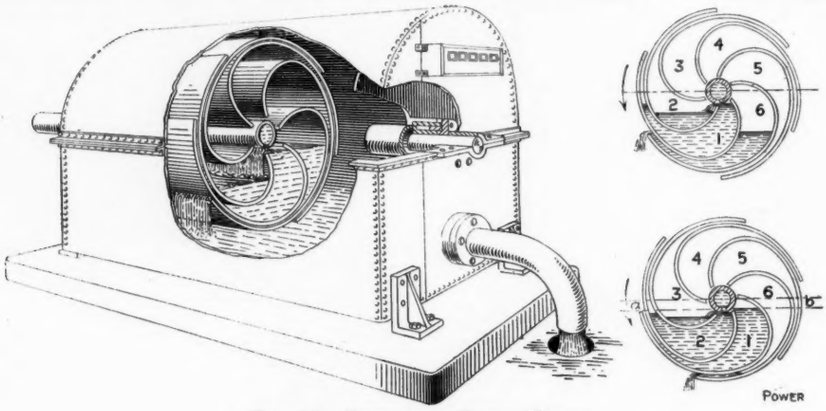


FIG. 11. REVOLVING DRUM METER

REVOLVING DRUM METER

In Fig. 11 is shown a drum meter of great accuracy. Dirty water, hot water, oils, etc., can be measured in this device with satisfaction.

The hollow shaft provided with a slot through which the water enters is held rigidly in place while the drum resting on rollers revolves around the shaft. The compartments of the drum are filled successively in such a way that always the one directly underneath the slot flows over; not until the compartment is overflowing can the drum move; sufficient water must first have flowed out of compartment 1 into compartment 2 before any motion can occur. The overflow from compartment 1 into compartment 2 continues until the discharge is as high as the water surface *a b*. But meanwhile compartment 1 has moved away from the slot in the rigid shaft through which the water enters so that the exact measure in the compartment is given at the very moment when the exit *a* stands as high as the water level in compartment 1. When the meter is in operation the center of gravity of the drum lies so that the direction of rotation is as indicated by the arrows. Each rotation of the drum is recorded and the quantity of water passed through the machine is thus measured.

WORTHINGTON STANDARD WATER METER

The Worthington standard water meter is one of the reciprocating-piston type. In general design it is somewhat similar to that of the well known duplex pump; the water is taken into the meter and discharged by two reciprocating plungers. Ports in the base of the meter admit and discharge the water. The chambers at either end of the plungers are alternately placed in communication with the inlet and discharge openings through the medium of small D-valves, these valves being actuated by the plungers in their backward and forward movements. One of the plungers imparts a reciprocating motion to a lever near the top of the main casing, which, in turn, operates the counter movement through a spindle and ratchet gear.

This type of meter is not suited to measuring feed water of greatly varying temperatures, but when used under the condition for which it is designed and when properly adjusted it gives excellent satisfaction.

WEIGHT DETERMINATORS

The Worthington recording liquid weigher, illustrated in Fig. 12, consists of two measuring tanks of equal size *A B*, each fitted at one end with a siphon pipe *C* and at the other end with weights *D*. The tanks are balanced on the knife edges *K*, which are located at less distance from the counterweights *D* than from the siphon pipes *C*. The liquid to be measured flows through the inlet pipe *E*, passing along the deflector *F* into either tank. The weights *D* are so adjusted that the tanks will remain in a horizontal position until they contain a certain definite weight of liquid; then they will tilt into the position shown by the dotted lines and the liquid will begin to flow through the siphon pipe. After the level of the liquid in the tank has fallen sufficiently, the tank tilts back again to its original position by the influence of the weights and the siphon continues in action until the tank is emptied. As each tank assumes the position indicated by the dotted lines it tilts over suddenly the deflector *F* so that the liquid does not continue to flow into that tank, but begins to flow into the second tank, where the operation is repeated. As each tank tips, the number of pounds contained is registered on a counter *G* which is actuated by the deflector *F*. It should be noted that the tilting of the tanks is accomplished entirely by the introduction into them of a definite weight of liquid, irrespective of variations in volume due to specific gravity or variations in temperature.

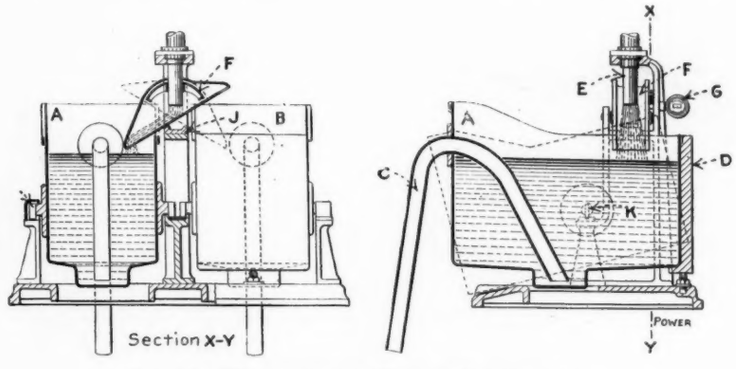


FIG. 12. WORTHINGTON WEIGHT DETERMINATOR

WILCOX WATER WEIGHER

Fig. 13 shows a water weigher which is used in many boiler houses and which seems to give universal satisfaction. The principle of this weigher consists in balancing the charge of water by a water column of fixed hight through the medium of an air cushion and then dumping the weighed charge automatically by releasing the cushion. The weigher is a tank divided by a diaphragm into an upper and a lower compartment; the former stores the entering water while the latter dumps the previously weighed charge. Projecting into the bottom of the lower compartment is a large U-shaped discharge pipe, always water sealed, and its projecting end is surrounded by a bell float which has a small up-and-down movement.

In the upper compartment is a standpipe, open at the top and bottom. The float and standpipe are connected by a rod so that they move together as one rigid piece, this being the only moving part in the machine. The lower end of

the standpipe is corrugated on its face, and when down its face rests on a soft ring surrounding an opening in the diaphragm. Water entering the inlet accumulates in the upper compartment until it overflows at the top of the standpipe. The water then spills down through the standpipe into the lower compartment and accumulates there until it lifts the bell float. As the float rises it lifts the standpipe from the opening and allows the accumulated water from the upper compartment to flow into the lower one. After the upper compartment empties, the inlet water flows along the bottom underneath the raised standpipe and into the lower compartment and gradually raises the level in the lower compartment until the dumping point is reached, which corresponds to a definite weight of water.

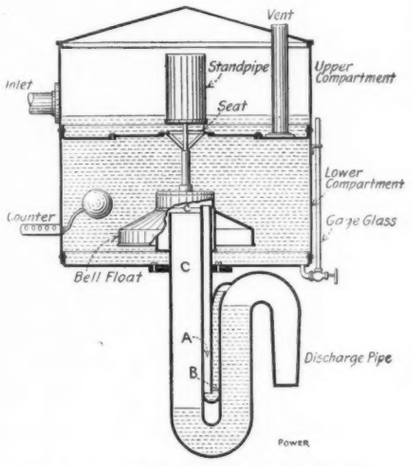


FIG. 13. WILCOX WATER WEIGHER

The weighed charge is at this moment automatically released and dumps through the large discharge pipe.

When the unit charge has begun to accumulate in the lower compartment, the air entrapped in the bell float and in the upper part of the discharge pipe is compressed. It should be remembered that the lower bend of the discharge pipe is always water sealed; that the air pressure in the bell float increases as the head of the water in the lower compartment increases, and that it balances exactly at all times the weight of the accumulated water.

In order to dump or trip the charge when the exact weight is reached it is only necessary to release the air suddenly from the bell float at the right instant and to permit the weighed charge to escape through the discharge pipe. This dumping is accomplished by means of a trip pipe that communicates with the compressed air in the discharge pipe just below the bottom of the lower compartment. The trip pipe is a manometer, normally water sealed, which automatically unseals itself at the dumping point in order to release the weighed charge. While the air pressure in the bell float and in the upper part of the discharge pipe increases, due to the accumulating charge, the water in the left-hand leg *A* of the manometer is slowly pushed down and a corresponding amount spills over the upper end of the right-hand leg *B* into the discharge pipe, forming a part of the next unit charge. This amount is a constant and is taken into account in calibrating the weigher. The lowering of the water level in leg *A* of the manometer continues until the level reaches the bend of the manometer. The water column in leg *B* is at this instant exactly balanced by the weight of water in the tank through the medium of the air cushion *C* in the bell float and the discharge pipe. If now only a few additional drops spill from leg *B* of the manometer to the water in the tank, the equilibrium is destroyed and the weighed charge dumps. The air in the bell float and in the upper part of the discharge pipe, which has been highly compressed by the water accumulated above it, suddenly blows the water from leg *B* of the manometer; then the air rushes through after the water. The bell float now drops, and the weighed charge siphons out of the lower compartment through the discharge pipe. The instant the bell float drops, and it drops very suddenly, it seats the standpipe in the upper compartment; by the downward pull, due to the water pressure above, the bell float and the suction of the siphon below hold the standpipe in place, thus preventing entrance of water from the upper compartment into the lower compartment while the unit charge is escaping.

When the standpipe seats as described, inlet water again begins to accumulate in the upper compartment until it once more overflows and the cycle of operation is repeated. A lever-operated mechanical counter, located conveniently on the shell of the weigher, records each weighed charge as it leaves the weigher. A gage glass provided on the weighing compartment shows the cycle of operation at a glance. Each weigher is guaranteed to weigh within 1 per cent. of absolute accuracy at any temperature from freezing to boiling.

Examiners and Licenses

BY JOSEPH KING

Looking up from the coal and water reports I had been figuring, I warmly greeted the young man who had formerly oiled for me, and who, much to my regret, had left me to locate in the western part of the state where he had figured a license could be more easily secured than in his home district. I had failed to find a satisfactory answer to his persistent question, "Why would I not have a better chance to secure a license in a district where the reports showed that 90 per cent. of the applicants were granted licenses, than in a district where only 49 per cent. were successful, and where I have twice been 'turned down'?"

"Well, my boy," I asked, as he drew up a chair, "how did your plans work out? You had your 'chances' pretty well figured out, so I suppose you walked right in and pulled out a 'first' with the same ease that the boys around these parts would get a second-class fireman's license?"

PLAYED IN TOUGH LUCK

"No," he replied, "I played in tough luck. I got a job all right, but instead of starting right in and taking my examination as soon as I had secured a 'residence,' I kept putting it off, and the first I knew the examiner I had taken so much trouble to become friendly with, was removed for some reason. When I went before his successor, I found him just as hard as the rest of them. It is strange that I cannot get a better license.

"Here I have been working in half a dozen plants in this state, and I have worked in plants all the way to California; I have fired boilers, run engines and worked in large plants, and I have 'made good,' or at least my employers have all tried to have me stay with them when I wanted to leave. They gave me good recommendations, yet when I come back to Massachusetts, where I want to locate, I can't convince the examiner that I am competent to hold an engineer's license."

His earnest manner of speaking warned me that levity on my part would be unseemly, so instead of commenting on the good opinion he evidently had of himself, and which I knew from his service with me was justified, I asked why it was that, with his experience, and the knowledge he had acquired from engineering books and magazines, and the seemingly inexhaustible stock of examination questions for which he was always seeking answers, he had so far failed to make a favorable impression with the examiners?

THE PERSONAL ELEMENT

He thought for a moment before answering. "It is because the personal element of the license law is allowed to enter into the examination room. I have been before several of the examiners and each has impressed me in a different way. Each one seems imbued with the idea of examining a man to find out how much he does not know about the business, and, believe me, they have a large field to work in. One examiner may confine his questions to subjects which require the use of certain formulas in answering. You may know where to look for the formula in the pocketbook but you are not allowed to consult such indispensable companions of the 'practical'

working engineer, so if you have not committed to memory the thousand and one rules and formulas to which the examiner resorts, you must eventually fail and be told to 'come up again.'

"The worst of all is the one who 'fires' his questions at you with the rapidity of a machine gun and changes from one subject to another, and who, when you have failed on some trivial question that he must know you could have answered had you been given time to consider, exhibits the same demoniacal glee as does the cheerful idiot at a party when he propounds a riddle the answer to which is so simple as to make you feel foolish that you did not think of it."

"But," I interrupted, "you have a chance to appeal if you feel aggrieved at the action of the examiner."

Oral versus Written Examinations

"Huh! What does that get you?" he responded. "You can go before three examiners who give you an entirely different examination from the one you made the kick over, and anything you may have observed detrimental to your chances of compelling the original examiner to grant the license can just about be multiplied by three when you go before the board. Why do they not have the examinations in writing so that the questions asked and the answers given can be submitted to an impartial board to determine whether the examiner erred in refusing to grant the license? The examinations for boiler inspectors and for chief inspector are given in writing, and it seems to me that a man after a permit to work at his trade is entitled to the same consideration as the seekers of positions higher up.

"They do not want to lose the despotic power of giving and denying licenses as they see fit, that's why. Think of the treatment accorded the late W. E. Crane, a man whose experience and versatility in answering engineering problems entitled him to be classed with the prominent operating engineers of the country. When he applied for a first, he was offered a second-class engineer's license, and when surprise was expressed, it is reported that the examiner's reply to an inquiry was that he did not know it was that W. E. Crane."

Variation in Percentages

Without waiting for a response, my young friend put on his overcoat and, taking from a pocket a loose-leaf notebook, he removed a page (the figures for which are given in the accompanying table) which he passed to me, saying:

"Here is a list of percentages of licenses granted by each inspector as compared to the whole number of applicants examined by him for the years 1908 to 1910. Look it over, and when I come in again I shall expect you to explain why there should be such a variation as 90 per cent. and 22 per cent. in the same year, and why certain examiners should maintain such a low percentage of licenses granted from year to year if there is any standard for conducting examinations. In fact, see if a study of the list does not tend to corroborate my statement that the form and manner of conducting license examinations in Massachusetts are responsible for much unnecessary injustice to the applicants for licenses."

PERCENTAGE OF ENGINEERS' GRANTED LICENSES

Inspector	1908	1909	1910
A	57	55	62
B	50	44	61
C	69	63	58
D	57	50	49
E	49	48	43
F	62	49	60
G	37	66	44
H	72	72	52
I	48	55	40
J	22	25	26
K	90	71	
L	58	51	55
M	58	61	51
N	58	36	29
O	61	59	59
P	79	73	66
Q	39	40	39
R	44	46	48

Use of Exhaust Steam

In a paper read by P. Barrett Coulston before the Manchester Geological and Mining Society on the use of exhaust steam, reference was made to a colliery where noncondensing engines of 1200 hp. per hour were installed. An exhaust-steam turbine, taking about 36,000 lb. of steam, with an electric generator and condensing plant, was then installed, with the following result:

The exhaust steam from the engine which drives the turbine plant gives 1000 kw. or, say, 1500 i.hp.; the 36,000 lb. of steam which must still be generated now yield 2700 instead of the original 1200 i.hp.; and the additional power obtained from the electrical set is being used for different purposes throughout the colliery.

Another example given is that of an engine of 1000 i.hp. which, when condensing, takes 15,000 lb. of steam per hour, and when run noncondensing, gives 900 i.hp. for 20,000 lb. of steam per hour. When the engine is noncondensing and the exhaust steam passes through a supplementary turbine, an additional 940 i.hp. is obtained, giving a total output for 20,000 lb. of steam, of 1840 i.hp. When the load demanded from the engine and turbine is reduced to 1000 i.hp., as happens during certain periods, it is obtained for 13,000 lb. of steam per hour; and, moreover, the combination remains more economical than with the engine alone running condensing until the load falls to between 400 and 500 i.hp.

Mr. Coulston recalls that the function of the exhaust-steam turbine lies in the capacity which it evinces to make efficient use of the higher vacuum, for the combination of a steam engine and the exhaust-steam turbine is simply that steam is passed through the engine, in which it does a certain amount of useful work, and then to the turbine, in which its remaining energy is used. Three items beyond dispute are: 1, the capital expended in the installation of the exhaust-steam turbine is low, being only that of the turbine set and its condenser; 2, the space is so small that the plant can almost invariably be installed in the existing engine room; 3, the pipe connections are very simple.

Increased efficiency is the chief advantage of the exhaust-steam turbine, due to either excess power for the same quantity of coal expended, or the same power for less coal.

In colliery work especially, the only possible way in which to utilize the exhaust steam is by means of a turbine. By the introduction of what is termed a "regenerative thermo-accumulator" it is a simple matter to supply steam to the turbine continuously, although the supply of steam from the engine to the accumulator is of an intermittent nature.

The type of accumulator most generally used, it is explained, is that of a large vessel or container filled with water or other material having heat-storing properties. The exhaust steam from the engine is led into this receptacle, and then supplied to the turbine. When the engine is running and supplying more steam than can be used by the turbine for the time being, the surplus is condensed in the accumulator at about atmospheric pressure, and the temperature and the pressure of the water rise gradually as more steam is condensed. When the engine stops, a drop in pressure at once occurs. As the steam is being constantly used by the turbine, recuperation takes place, and sufficient steam is supplied to the turbine to bridge the gap between the time of starting and stopping the engine.

It is pointed out that where the stoppage of operations is of too long duration to be bridged by an accumulator of normal size, it is only necessary to fit a reducing valve, by which means live steam from the boilers can be automatically supplied to the turbine when the pressure in the accumulator falls below a predetermined figure.

Mr. Coulston concludes by saying that the capital cost of the turbine is at least as low as that of any form of prime mover, while from the point of view of running costs, all the power recovered is pure gain; for, after passing the steam through the turbine, it becomes condensed, and may be again fed to the boilers, thus obviously saving water, which, in some cases, at any rate, is an item of no small value.

The world's total coal production in 1910 was approximately 1,300,000,000 short tons, of which the United States contributed about 39 per cent.

Fuel Economy and CO_2 Recorders

By A. D. Williams

A review of the subject of combustion and fuel economy. CO_2 alone is not a perfect index of combustion efficiency.

Three types of automatic CO_2 recorder are discussed. The fireman can cheat the intermittent type.

Fuel economy is an important item of power-plant economy, but in most plants the only method of determining fuel economy is by a comparison of the amount of fuel burned in securing a unit output with past records. This may be a very crude method, but in the final analysis the number of cents' worth of fuel consumed in turning out a dollar's worth of product is the real test of economical combustion. The actual cost of any fuel is not that nominal price found on the bill of the dealer supplying it, but includes a number of other items, such as the cost of unloading into the bunker, of moving from the bunker to the fire, of removing the ashes and disposing of them and the interest on the average amount of capital tied up in the reserve supply of fuel. The number of pounds of coal burned per unit of product will vary with the thermal value of the fuel, the amount of ash it contains and the economy with which the process of combustion is effected. The temperature and the proportion of the gaseous components of the products of combustion must be known in order to definitely fix the economy of the process. The quantity of unburned combustible in the ash is also a step in fixing the plant fuel economy.

Theoretically perfect combustion is unobtainable except under the most favorable laboratory conditions, and even then the chances of success are slight. In the boiler room the process of combustion must be reduced to commercial values and the failure to maintain the steam pressure cannot be atoned for by reduced fuel consumption. There are four important factors which tell the story of fuel economy as indicated by the flue gases, carbon dioxide; carbon monoxide, oxygen and sensible heat. By itself, the percentage of carbon dioxide is only an imperfect indication of the economy of combustion.

Combustion is a complex chemical reaction and in a boiler furnace and setting there is often primary combustion in the furnace and secondary combustion in the gas passages; the latter is due to a partial combustion in the furnace forming carbon monoxide which burns to carbon dioxide by combining with oxygen entering the flue through leaks in its wall or leaks in the boiler setting. The composition of the gases of combustion will vary considerably at different points in the combustion chamber, the percentage of carbon dioxide usually increasing as the distance from the fuel bed increases. This is due to the fact that the chemical reactions occurring require an appreciable time and to secondary combustion. A low percentage of carbon dioxide may be accompanied by a surplus of carbon monoxide or oxygen or a surplus of both, and high percentages of carbon dioxide and carbon monoxide may occur simultaneously with surplus oxygen. The chemical union of carbon and oxygen generates heat, but this union does not occur if the gases are below the ignition temperature. Unburned volatile hydrocarbons may be lost in this manner.

Carbon-dioxide recorders are generally connected to the smoke flue immediately outside of the boiler setting. The point of attachment should be the same at all flues to insure the proper comparative value for the diagrams from different boilers. As the recorder itself is a delicate piece of apparatus, it must be placed where it can be watched and receive proper attention. Therefore it is necessary to introduce a pipe connection of greater or less length between the recorder and the boiler flue from which the gases are to be drawn. This pipe connection introduces the element of time lag between the record and the flue condition it represents, as an appreciable time will be required for the gases to pass through the pipe to the recorder. The time lag can be reduced by the use of an aspirator to keep up a continuous flow of flue gases in the connection pipe. One of the advantages arising from a long pipe connection is the opportunity it affords for the cooling of the flue gases.

Carbon-dioxide Recorders

Many carbon-dioxide recorders are fragile and require a certain amount of attention and a delicate touch. This apparatus has often been placed under the care of a man who, while intelligent enough for the purpose, had a hand trained to the shovel or a big monkey wrench; he did the best he could, but the recorder suffered. This kind of attention has caused a number of recorder installations to go out of service.

In method of taking samples there are two types of recorder, one in which the sample is taken at intervals of from five to ten minutes or more; the other in which the sample is passed through the apparatus in a continuous stream. This last method is inherently more accurate than any other as it furnishes a sample which tells the story at every minute the recorder is in operation.

The intermittent-sampling method may be accurate enough as to the analysis of each sample, but there is nothing to tell what is happening in the interval between the taking of samples. This interval has to be sufficiently long to permit the potassium-hydrate solution to absorb the carbon dioxide, and as a fresh solution acts more rapidly than one nearly saturated with gas, the time must be fixed to suit the slowest-acting solution; otherwise the accuracy of the indication will be seriously impaired.

One of the serious disadvantages of the intermittent method of sampling arises from the fact that the fireman can readily approximate the time interval and lag of the apparatus and so arrange his work that the admission of surplus air to the furnace occurs during the periods when samples are not being taken. This will result in a good card on the recorder but one which is not a fair representative of the operating condition under which it is supposed to be taken. Beating the recorder in this manner is particularly liable to occur in plants where the firemen receive a bonus based on the recorder indications.

Continuous-sample Recorders

Continuous-sample carbon-dioxide recorders are of two types, one in which the specific gravity of the gases flowing through the machine is indicated by a delicate balance; the other operating upon the principle of the flow of gases through small orifices into a partial vacuum. The differences in weight due to varying percentages of carbon dioxide are extremely slight; therefore the scale or balance capable of detecting and indicating these changes in the specific gravity of the gases is a very delicate one. Apparatus of this kind must be accurately leveled and so located that it will not be subjected to vibration or shocks. The more sensitive this scale the less is its suitability for a place in the boiler room.

One of the weakest points about the balance type of construction arises from the necessary exposure of the metal parts of the apparatus to the waste gases, which frequently are of a corrosive nature owing to the presence of sulphur dioxide. Glass parts and agate knife edges are occasionally used, but these last will gradually lose their accuracy. This type of recorder may be supplied without the automatic recording device and used as a carbon-dioxide indicator.

The third type of carbon-dioxide recorder consists of a chamber into which the gas flows through a small orifice and from which it is drawn through an orifice of the same size, into a chamber in which a partial vacuum is maintained. Means are provided by which the flowing gas and the orifices through which it passes are maintained at a constant temperature. As long as the same volume of gas passes through both orifices the vacuum in the first chamber will be one-half the vacuum in the second chamber; but if after passing the first orifice one of the constituents of the gas is removed, its volume is reduced and the vacuum in the first chamber will be increased. This increase in the vacuum will be an exact measure of the volume of gas absorbed. In the carbon-dioxide recorder operating upon this principle the first chamber is filled with quartz pebbles which are kept moist with a solution of potassium hydroxide flowing over them from a gravity source of supply. This provides a large amount of absorption surface and a continual supply of fresh solution. The difference between the vacuum in the first and second chamber is recorded upon a chart actuated by a clock movement.

The records of all carbon-dioxide recorders should be checked from time to time by the use of the Orsat apparatus, and, where possible, this apparatus should be used daily. This is probably the most widely known and used device for flue-gas analysis. It enables a quantitative determination of carbon dioxide, carbon monoxide, oxygen and nitrogen to be made in about one-half hour, including the time necessary to secure the sample. This apparatus is portable and convenient. Where this apparatus is used a close check can be kept upon the conditions of the boiler settings and the amount of air infiltration as samples of the gases of combustion can be obtained from any part of the setting or the gas passages.

As temperature and barometric pressure affect the volume of the flue gases and furnace conditions, it is advisable to use a recording thermometer or thermograph supplying a record of the temperature of the air and the flue gases. A barograph or recording barometer for keeping track of the barometric conditions and a recording draft gage are also desirable additions to the power-plant laboratory. This latter apparatus, however, can be dispensed with; in fact, most power plants consider they have gone the limit on boiler-room jewelry when they put in a recording steam gage.

The boiler room is the place where the biggest opportunity for cutting down operating expenses lies and the chemical reactions occurring in the boiler furnace must be carefully watched in order to attain practicable efficiency.

A complete set of records of this character covering one or two years would be invaluable in settling many of the complex points involved in power-plant operation and would supply an interesting light upon the subject of chimney draft. In this last case, the record should be accompanied by information as to the number of boilers in operation at all times and to the steam temperatures and pressures maintained.

Hoisting Engine Repair Job

Looking at the long lines of mine steam pipes, some of them 3500 ft. long and over, the problem of taking care of the condensed steam is apparent. This condensate is taken care of by means of traps and separators, but occasionally these devices fail to operate and a wrecked engine is the result.

One morning, several years ago, after a 32x48-in. first-motion hoisting engine had been running as usual for about an hour, both cylinders received a slug of water which resulted in cracking both engine frames on the under sides of the

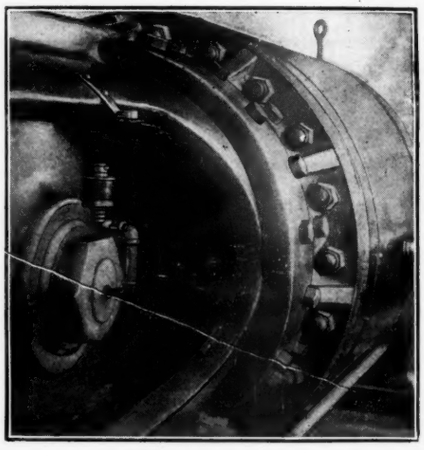


FIG. 1. CASTING FITTED TO FRAME OF ENGINE

throat, next to the flange where it is bolted to the cylinder. The engine bed was also broken on one side at the pillow block, either one of the fractures being so severe as to render the engine useless until a new frame could be obtained or repairs made.

Chief Machinist Morgan, of the Susquehanna Coal Co., at Nanticoke, Penn., decided upon and carried out the repairs as follows: A heavy casting was made to fit on the outside of the engine frame and was flanged to the same size as the frame and the cylinder. Long stud-bolts were used instead of the engine studs, and clearance holes were drilled in the casting to match those in the engine frame. Another set of holes were drilled and tapped in the frame and corresponding holes drilled in the casting. Cap-bolts were then screwed tightly in place. The nuts on the stud-bolts were then screwed up tight. Ribs were made on the casting to strengthen it. A 1¼-in. rod was screwed into the base of the engine frame on each side of the cylinder and also pressed through the foot at the head end of the cylinder. These rods were made tight by nuts and the whole served to prevent the cylinder from pulling away from the frame; both cylinders were treated in the same manner The repair is shown in Fig. 1.

Securing the pillow block to the frame was a more difficult job, but it was ac-

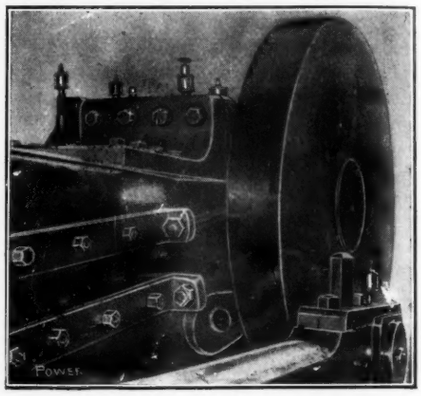


FIG. 2. SPECIAL PILLOW BLOCK CAP FITTED TO FRAME

complished by making a new cup for the bearing, having a shoulder cast on the inner end. A special casting was made to butt against this shoulder and to extend out on top of the engine frame, as shown in Fig. 2. The two shoulders were held together by five 1½-in. bolts; the angle casting was secured to the engine bed by eleven 1-in. capscrews.

On each side of the frame two angle irons were secured by 1-in. bolts and the

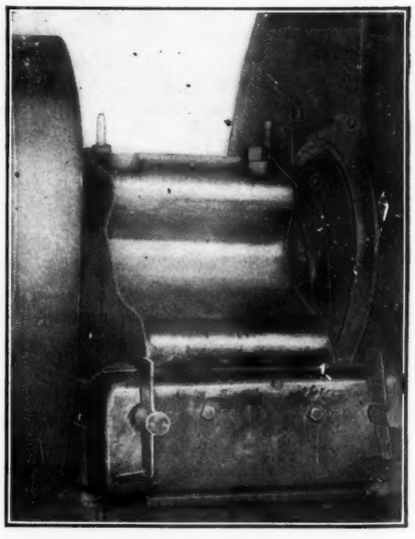


FIG. 3. APPLICATION OF CASTING AND TIE RODS

angle end of each was drilled for a 1¼-in. stay-rod; the inner end of each was screwed into the projecting end of the pillow block of the crank disk. The other end of each rod passed through the hole in the angle iron and was made tight by a nut, as shown.

To make the job more secure, a small casting was made to fit against the outer end of the frame and pillow block. Two holes were drilled in it for two 2-in. rods which were slotted for a key as shown in Fig. 3. The other end of each rod was fastened, drilled and secured to the engine frame by a bolt which extended through the engine frame and both eyes of the two bolts, as shown just back of the crank disk in Fig. 2. The bolts drew the frame tight at the bottom and prevented end-play at that point.

This completed the job, and the engine has been in use during working hours for a period of about three years, which speaks well for the manner in which the work was performed.

Setting Valves on a Corliss Engine

By H. P. Porter.

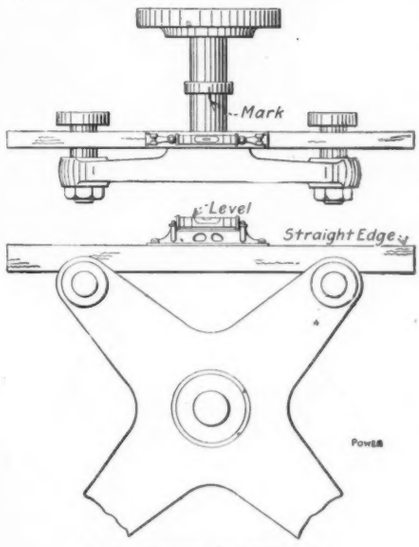
To set the valves on a simple Corliss engine of any design is not always as easy as might be supposed. While many have the principal motions of the gear fairly well in mind, and others understand it well, it is not uncommon to find a man in charge of large engines who cannot tell in a straightforward way how to go about setting the valves.

There are six principal operations to perform in setting the valves, these are as follows:—

1. To set the wristplate.
2. To adjust the valves.
3. To equalize the travel.
4. To put the engine on the center.
5. To set the eccentric.
6. To adjust the governor rods.

For example, consider any sized engine of a simple type having one cylinder. To set the wristplate, first note if there is a manufacturer's mark indicating when it is in the central position of its travel. If there is no such mark, in the case of a horizontal engine, use a straight edge and level, as in Fig. 1, bringing the steam rod pins level, then mark the wristplate so that the mark comes on both the moving part of the hub and the stationary part of the shaft or stand. In order to do this it may be found necessary to disconnect the steam rods. In the case of a vertical engine the steam-rod pins would be vertical, or in any case they would be parallel with the center line of the engine.

To adjust the valves, after the wristplate is in its central position, it is first necessary to know just how much lap the valves must have. This information should ordinarily be secured from the manufacturer although in some cases the engineer may set the valves by guesswork and later adjust them correctly with the aid of an indicator. There is quite a difference in the amount of lap of the valves for the same sized engines of different designs. The writer has in mind one manufacturer who for a 16-in. diameter cylinder sets the steam valves with $\frac{3}{8}$ in. lap and the exhaust valves with $\frac{1}{16}$ in. lap, while another manufacturer allows the steam valve $\frac{1}{8}$ in. lap for every 10 in. diameter of cylinder and sets the exhaust valves without any lap. For a 16-in. cylinder this would give the steam valves 0.2 in. lap. There are other manufacturers who would give this same engine about $\frac{5}{16}$ in. lap for the same engine and $\frac{1}{32}$ in. negative lap for the exhaust valves. This goes to show that all gears are not designed to give the same laps of the valves for the same size of engines. Again, the data given on this subject by the manufacturers is not always absolutely correct for every case; they cannot always foretell what conditions the engine may work under, and in the end, the valves should always be readjusted by means of the steam-engine indicator.



CENTERING WRISTPLATE

To equalize the travel of the wristplate, is to so adjust the eccentric and reach rods that the plate moves during one complete revolution of the engine, the same distance on either side of the center as indicated by the mark on the hub. This is accomplished by either revolving the engine or by loosening the eccentric on the shaft and revolving it around the shaft. While making this revolution, note the travel of the wristplate, and shorten or lengthen the eccentric rods as the case demands so that the plate travel is equalized. Also while making these adjustments, as well as all others of like nature, it is well to have all the bearings adjusted so that there will be no lost motion, and the revolution should be in the direction the engine is to run.

To put the engine on center, turn it over until the crosshead is nearing one end of its stroke, then stop and mark the position of the crosshead on the guides, and before moving the engine also mark some point on the rim of the flywheel on some stationary object near by. If there is no such stationary object, construct one, then continue to turn the engine until the crosshead passes the center and returns exactly to the same position as when marked; then mark the rim of the flywheel from the same point on the stationary object again. Take a pair of dividers and locate a point on the rim half way between these marks. This half-way point is then brought to the same position relative to the stationary object as were the original marks when made, and the engine is on center.

To set the eccentric, the engine must remain on center while the eccentric is revolved around the shaft in the direction it is to run, at the same time noting when the steam valve (on the end corresponding to that at which the crank is set) begins to open. When this valve has opened the necessary amount for the lead, make the eccentric fast to the engine shaft by tightening the setscrews, and also mark the eccentric for future references. For an engine having a 6-in. cylinder the lead might be $\frac{1}{32}$ to $\frac{1}{16}$ in., depending upon the speed at which the engine is to run; the greater the speed the more the lead.

To equalize the governor rods and adjust the cutoff, block up the governor to the position in which it should run at medium full load; this will on most engines be between $\frac{3}{4}$ and $1\frac{1}{4}$. Then rock the wristplate and note that the knockoff blocks disengage the hooks from the valve arms at the same point each side of the center, or turn the engine to $\frac{1}{4}$ of its stroke and adjust the rods so that they knock off the valve at this point for each stroke.

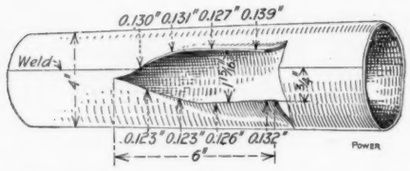
Seneca River Boiler Tube Blowout

There have been no new developments of importance regarding the fatal boiler-tube blowout on the dredge "Clyde" on Nov. 16, in which four men were killed, as reported in POWER for Nov. 28.

The "Clyde" was equipped with two Babcock & Wilcox 400-hp. marine boilers, the one which failed being located on the starboard side. The boilers were run continuously night and day under full evaporation at the time of the accident. The burst tube was one at the end of the lowest row and the fracture occurred on the underside of the tube about 6 in. from the bridge-wall. The longitudinal fracture was about 6 in. long and the traverse about 4 in. long.

The boilers, which had been in use for three years, operated at 175 lb. gage. The engines were run condensing and the condensed water was used in the boilers.

As stated in the issue of Jan. 2, the failure of the tube from an engineering standpoint, was believed to be due either to defective material or to material weakened by pitting or corrosion, or by overheating; there was nothing to show the existence of excessive pressure. This opinion was later borne out by the dis-



THICKNESS OF METAL AT FRACTURE

covery that a slight trace of oil was observed at the water line and that it is possible that enough oil got into the boiler to allow the tube to overheat. Turkish toweling and straw filters were used.

There was no drawing down of the metal to speak of, the rent being as shown in the accompanying drawing.

Designing a Bearing

BY PROF. R. C. H. HECK

In commenting upon a poorly designed bearing in the issue of October 10, C. R. McGahey draws some inferences which a closer study and a clearer understanding of the problem show to be outside the limits of possibility. The arrangement criticized is reproduced in Fig. 1, with the addition of dimensions appropriate to an engine with the speed named, or running at 240 revolutions per minute. It was claimed that the bearing shells, instead of having only a narrow support at midlength, ought to be rigidly held in the frame of the machine; and to this supposedly insufficient rigidity of support and consequent flexure of the shaft was attributed, in one case, a vibration or "wabble" of the wheel rim, having an amplitude of $\frac{3}{16}$ inch. It is now proposed to work out definite results for the conditions represented in Fig. 1; and even though an acquaintance with the "mechanics of materials" is needed for a complete understanding of the methods used, an outline of the calculation may be of general interest.

OUTLINE OF CALCULATION

First of all, the connecting-rod pressure $P = 20{,}000$ pounds is about as heavy a load as is likely to come on a 6-inch shaft; it would be produced by an effective steam pressure of 130 pounds per square inch on a 14-inch piston or 113 pounds on one of 15 inches diameter. If this load is resisted by pressures $R\,R$ concentrated at midlength of the bearings, it would develop a maximum stress of about 6000 pounds per square inch in the crank pin or right under P, Fig. 1. In briefest outline, without any explanations, the calculation of this stress is as follows:

The shaft is considered a simple beam, 26 inches long, and with a load of 20,000 pounds at the middle. The moment of inertia of the section is

$$I = \frac{\pi d^4}{64} = \frac{3.142 \times 6^4}{64} = 63.6$$

The section modulus, with the radius 3 inches as the distance to remotest fiber, is then

$$\frac{I}{c} = 63.6 \div 3 = 21.2$$

The maximum bending moment is

$$M = \tfrac{1}{4}\,Pl = 20{,}000 \times 6.5 = 130{,}000 \textit{ inch-pounds}$$

Therefore the greatest stress is

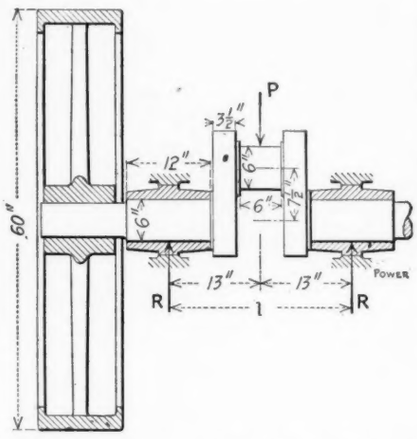


FIG. 1. DIMENSIONS OF SHAFT AND BEARINGS

$$S = 130{,}000 \div 21.2 = 6130 \textit{ pounds per square inch}$$

Provided that the crank webs are of sufficient strength, the crooked form of the shaft has no influence upon stress in the crank pin; but it does help to determine the flexure under load. To allow, roughly, for bending in the crank webs, let the actual shaft be replaced by a straight round bar of the increased length (between supports), shown in Fig. 2, and with a load at the middle sufficient to produce a stress of 6000 pounds. The stress along the bar will vary from this maximum value under P to zero at the supports, in the manner represented by the shaded diagram $A\,K\,B\,A$.

STRESS

Stress is the inner force which resists the tendency of external forces to change the shape of the body; but the development of stress is accompanied by some change of shape. The bending action of the forces P, R, R, in Fig. 2, produces compression and shortening on the top side of the bar, and tension and stretch along the bottom. Change of length is proportional to the stress developed, and the ratio of stress per unit of area to elongation (or shortening) per unit of length is called the modulus of elasticity. For steel this ratio is about 30,000,000. As already noted, in this example the stress varies uniformly from 6000 pounds per square inch to zero; and the resultant effect is as if an average stress of 3000 pounds were assumed to exist along the whole bar. Dividing 3000 by 30,000,000, the length of the bar will be changed by 1 in 10,000 of its free length. Then the 32 inches at $A\,B$ will be shortened by 0.0032 inch, while at $C\,D$ there will be a stretch of 0.0032 inch. Now the lines $C\,A$ and $D\,B$, originally parallel, will approach each other at the rate of 0.0064 inch in 6 inches, or of 1 in 940. From its original position parallel to $M\,N$, either line will be deflected at half this rate, or by 1 in 1880.

Suppose that a wheel of 60 inches diameter is mounted on the shaft, as in Fig. 1. To give a 30-inch radius a deflection of 1 in 1880 would swing the outer end of it

$$30 \div 1880 = 0.016$$

or about $\frac{1}{64}$ inch, from its mean position; and with the same deflection in the opposite direction, the total range of vibration would be about $\frac{1}{32}$ inch. The load assumed in Fig. 1 is larger than would be likely to come into play in the ordinary working of the engine; and if a wheel were observed to vibrate through $\frac{3}{16}$ of an inch, it certainly was not set squarely on the shaft.

PROPER SUPPORT FOR BEARINGS

So much for the matter of probable quantitative values of stress and flexure.

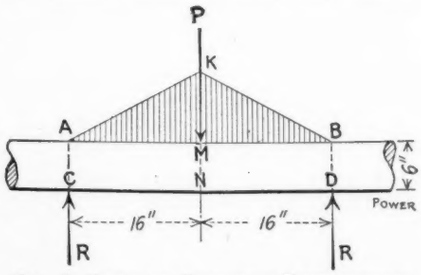


FIG. 2. DIAGRAM SHOWING DISTRIBUTION OF STRESS

Next comes the question of proper support for the bearings. The determining requirement for cool and easy running of a high-speed bearing is uniformity in distribution of pressure between the journal and the bearing. If the bearings in Fig. 1 are held rigidly and exactly parallel to the axis of rotation, and if the shaft bends under varying load (as it must), one end of the journal will be pressed harder than the other against the bearing. The fact that most engines of the class represented have full-length seatings for the boxes in the frame, and yet work satisfactorily, means simply that the shaft flexure is not large enough to cause trouble. The use of flexible support, which permits the bearing shell always to aline itself with the bearing, is universal for line shafting and very

common in large engines and in steam turbines. The original design of the center-crank engine most like Fig. 1 had spherical seatings for the bearings in the frame. This is correct in principle, but has been found an unnecessary refinement for small engines.

Of course, if a heavy wheel is not set squarely on the shaft, the resulting vibration will strain the arms severely; but no standard high-speed engine on the market has a shaft light and flexible enough to permit serious vibration of this sort, due to flexure under steam force.

Cast-Iron Head Blown Out of Steam Dome

An unusual boiler explosion occurred at 9:45 a.m., Monday, Jan. 9, at 98 First Ave., New York City. The boiler was 12 ft. long, 36 in. in diameter and was constructed with a shell ⅜ in. thick and with heads ½ in. thick. The shell metal had a tensile strength of 50,000 lb. The boiler was located in the basement of Dorsch & Co., and was used to supply steam for heating and power purposes.

The boiler was set under the sidewalk with the top of the steam dome about 12 in. from the arch which forms the ceiling of the boiler room. The rupture in the boiler occurred in the cast-iron head of the steam dome, the head being 1⅜ in. thick and 30 in. in diameter. It fractured at the flange and was probably blown into small pieces as it cannot be found. The top of the dome was blown up through the sidewalk, slightly injuring two men, the engineer and a passer-by.

The boiler was 32 years old, having been built in 1880, and underwent a 120-lb. hydrostatic test on Oct. 25, 1911. The pressure allowed on the boiler was 80 lb. In Fig. 1 is shown a partial view of the boiler setting and the steam dome; Fig. 2 shows a view of the power plant, which consisted of a steam and gas engine, a small refrigerating machine and other small units. Aside from the damage done to the boiler dome and some of the piping, the boiler was not damaged. It is doubtful, however, if it will be again put into service, as a new boiler is being installed. No blame is attached to the engineer in charge at the time.

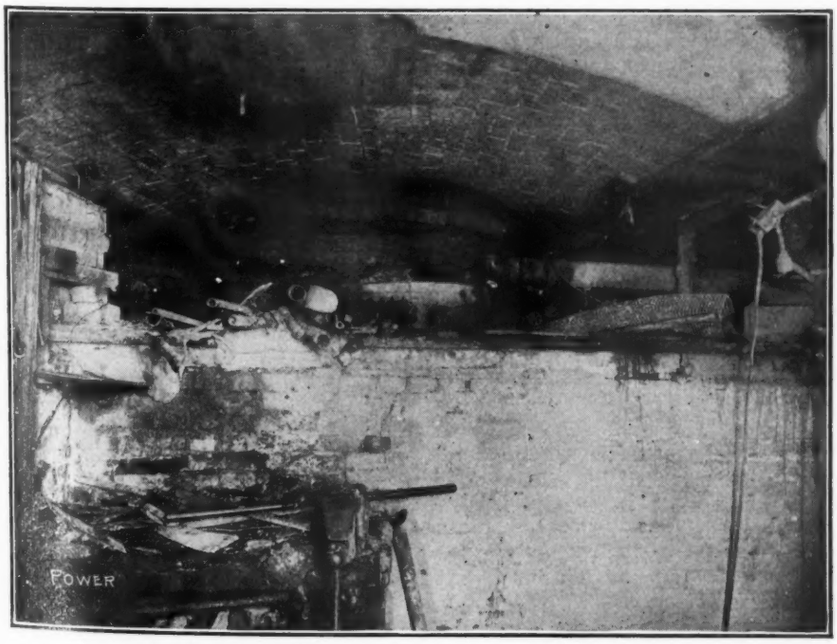


FIG. 1. BOILER UNDER SIDEWALK. CAST-IRON HEAD OF DOME WAS BLOWN UP THROUGH THE ARCH AND SIDEWALK

New York's Hydro-Electric Possibilities

Governor Dix, in his latest message to the New York Legislature, gives serious consideration to the state's hydro-electric possibilities in the following words:

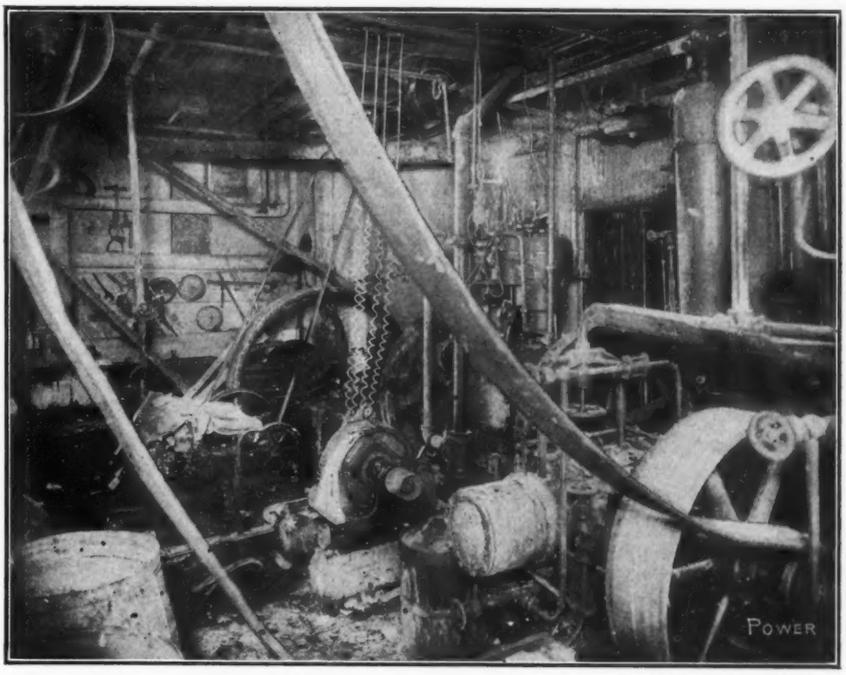


FIG. 2. HOW THE ENGINE ROOM LOOKED AFTER THE EXPLOSION

New York State is unique in its possession of hydraulic energy. Surrounded by water on its entire western, northern and southern borders, there is a possibility of developing from latent energy, not at present utilized, one and a half million horsepower, which can be distributed through feeders along the line of the Erie Canal and the Champlain Canal, that will be extending through the southern tier of counties sufficient energy to create in perpetuity the power now supplied by the annual consumption of twenty million tons of coal.

It is estimated that the state's industries purchase from neighboring states an equivalent of 1½ million horsepower in coal alone; that in New York City one railway annually consumes 500,000 tons of hard coal and 150,000 tons of soft coal, and another burns 350,000 tons; steam users, 2,000,000 tons; houses, hotels, stores, etc., 1,500,000 tons, and families, 1,000,000 tons—in all, says the *Coal Trade Journal*, as nearly as can be estimated, there are 19,184,846 tons consumed annually in Greater New York.

These figures are startling, and are a strong argument in favor of the necessity of the state adopting every means of conserving its vast water-power resources.

While the state will be compelled to make heavy expenditures before its hydro-electric resources are made commercially available, their development will make New York one of the wealthiest and most prosperous states in the world.

Electrical Department

Conducted to be of service to the men in charge of electrical equipment in the power house

Old Reliable Steam to the Rescue—Under Difficulties

By R. C. Turner

An occurrence which illustrates the advantage of having a steam plant to supplement water power added to the experience of the Georgia Power Co., at Atlanta, recently. This company operates two hydro-electric stations on the Chattahoochee River, one at Morgans Falls, 18 miles from Atlanta, and the other at Gainesville, Ga., 55 miles north of the same city. At the Morgans Falls plant, the equipment consists of six three-phase machines with a suitable equipment of water-cooled transformers for raising the voltage to 22,000 and the delivery of 15,000 hp. at the station switchboard. The whole output of this station is transmitted to Atlanta and sold to the Georgia Ry. & Electric Co. After going through the substation at the city limits the current is delivered to the railway company at 6600 volts. The purchaser operates all the traction cars in the city and also furnishes the street lights as well as a heavy residential and commercial load. The Gainesville plant has a rated capacity of 12,000 hp. and furnishes the cities of Gainesville, Buford and Norcross with electric lights and power.

The current coming into Atlanta from the Gainesville plant is transformed at the city limits from 50,000 to 11,000 volts, and is distributed in the city at this voltage, the service being used mostly by manufacturers.

Early in September the management of the Georgia Power Co. realized that if it did not rain in a few days the river would be so low at the Gainesville and Morgans Falls plants that it would be impossible to operate more than a few hours during the day. The Georgia Ry. & Electric Co., however, offered to render all the assistance possible with its steam plants, the Georgia Power Co. to furnish all the transformers and other apparatus needed.

The Georgia Power Co. sent six 600-kw. 11,000- to 2300-volt transformers to the Davis St. plant of the Georgia Ry. & Electric Co., and the 2300-volt feed line coming from the Georgia Ry. steam plant was connected to the corresponding terminals of the transformers, the 11,000-volt terminals being connected to a temporary line from the Davis St. plant to a substation located near-by. At the substation a spare transmission line from the Morgans Falls plant was hooked on, giving an 11,000-volt line out to the city limits. At the outer district temporary lines were run and single-pole knife switches installed and connected to the transmission line from the Gainesville plant, 50 miles away. Two miles from the temporary jumpers and switches, the line enters the North Boulevard substation for the final step-up from 11,000 to 50,000 volts, this being the voltage used between the North Boulevard station and the generating plant at Gainesville.

When everything was completed, the steam plant was notified to cut in at 10 p.m. and carry the load of the Gainesville plant from this hour until 2 p.m. the following day. At the Gainesville plant the head gates were to be closed at 10 p.m. and water stored up in order to be able to take up the load at 2 p.m. every day until it rained enough to relieve the situation.

Following out the order, engineers at the Davis St. plant at 10 p.m. threw in the switches, paralleled with the Gainesville plant and picked up the load, the Gainesville plant cutting out at 10:05. For ten minutes everything worked nicely; then three of the 600-kw. transformers at the Davis St. station went up in smoke before the attendants could cut them out of the circuit; the other transformers were cut out and the Gainesville plant had to pick up the load again.

On the following day, upon examining the remaining 600-kw. transformers, it was decided that the accident was caused by moisture, as the transformers had been out of service for several years. After making this decision, the secondary terminals were short-circuited and 220 volts sent into the primary windings to heat them up and expel the moisture. Steam-pipe coils were also employed to hurry up the job of drying them out. After a few days the transformers were subjected to a severe insulation test and put back on the line; at 10 o'clock that night the Davis St. plant again took up the load of the Gainesville plant. Everything worked perfectly for a few days; then the transformers which had been subjected to the drying-out process followed the fate of the first three and went up in smoke.

After the failure of the second bank of transformers, three spare 1500-kw. transformers at the Morgans Falls substation were connected up and worked perfectly for several nights, when one of them, carrying less than three-fourths of its rated load, followed the fate of the first ones and went out of commission. When this happened, the engineers of the company decided that they were about at the end of the rope, as the drying-out process on the remaining 600-kw. transformers was not completed and they were unwilling to run the risk of any more burnouts. However, on the date of the last burnout, word was received from the Gainesville plant that a heavy rain had fallen in that vicinity for the past 24 hours, breaking the 60-day dry spell, and that they would be able to operate the plant 24 hours per day until further notice.

LETTERS

How to Color Lamp Bulbs

In the Jan. 2 issue, Harry L. Seifts asks for a process to color lamp bulbs. There are several different methods; a simple and inexpensive one is as follows: Take some white shellac and thin it down with wood alcohol, using considerable of the alcohol to get a very thin mixture. Dissolve some ordinary powder dye, of the color desired, in some alcohol and mix it with the thinned shellac. Place the mixture in a vessel at least 6 in. deep, and immerse the bulb in it, taking care not to dip the lamp deep enough to get the base in. After dipping, the lamp should be hung vertically in a socket and the current turned on to dry it. Any depth of color desired can be secured by properly proportioning the quantity of the dye in the shellac. If necessary, the coloring can be removed from the bulb with alcohol. A good coloring liquid can be bought especially made for bulb coloring from dealers in electric goods.

James E. Noble.

Toronto, Ont.

Answering Mr. Seifts' question as to treating lamp bulbs, I offer the following suggestions:

Take a little white shellac and cut it with alcohol; dip the bulb in this mixture and let dry, when it will be a good imitation of frosted or ground glass. For coloring, take a little egg dye of the color desired and dissolve it in a little alcohol and color the shellac with it. When desired the color can be cleaned off with alcohol.

Another method is to dip the bulb in a solution of collodion, in which an aniline dye of the desired color has been dissolved. These dyes can be obtained at any drug store, and are about the same as the egg dyes. When dipping, care should be taken not to wet the base of the lamp.

EDWARD L. JOHNSON.

Brooklyn, N. Y.

Polarity of the Cooper Hewitt Lamp

In the Catechism of Electricity on page 15, Jan. 2 issue, the reference to the polarity of the Cooper Hewitt tube is evidently reversed. The letter *A* should be at the right-hand end and the letter *C* at the left-hand end of the tube in Fig. 393.

E. G. HOPPE.

Cairo, Ill.

[Mr. Hoppe is right. The letters *A* and *C* should have been transposed. The fourth line of text beneath the picture should have read: "large bulb *A* at the right-hand end of the tube" and the seventh line below the picture: "cup *C* at the left-hand end of the tube."—EDITOR.]

The Cash Value of Electrical Knowledge

The worth of electrical knowledge does not appear to be very large, to judge by the growls in the press on the matter of engineers' wages. On this side of the Atlantic, at any rate, we know how to fix the pay sheets. The following advertisement is from the *Manchester Guardian* of Nov. 21:

WANTED, in Mains, etc., Department of Electricity Supply Station, near Manchester, man to install, maintain and repair motors and make himself generally useful in the Department; one able to fix and read meters; wage to commence £1 ($4.87) per week of 50 hours, with prospect of increase for satisfactory man. Address R 62, M/c Guardian.

It is gratifying to note that a satisfactory man will have a "prospect of increase." It is, however, to be hoped that the prospect will not be so dazzling as to cause any hurt to the eyes of the prospector.

There are not many better-paid jobs than the electrician's, are there? What? Oh, yes! I'm so sorry; I forgot the art of road-sweeping. Members of this profession have attained, I believe, to the munificent salary of 25 shillings per week of 48 hours. Really, I must find an experienced road-sweeper and apprentice my young hopeful to him without delay. I hope that he will not demand an exorbitant premium.

JOHN S. LEESE.

Manchester, Eng.

Unbalanced Airgaps and Bearing Wear

Under the above heading on page 922 of the Dec. 19 issue, is an article by Mr. J. B. Clapper which leaves room for much comment. The author writes of the possible decrease in service or shutdown of a power plant for a trifling cause. I fail to see how his theory can hold good for so long as three weeks.

In most cases of unbalanced airgaps the magnetic pull has such a slight difference between the opposite polepieces that the readjustment is generally made to prevent the armature from striking the poles on the bottom. If the magnetic pull on the bottom pole were 3000 lb. it would be balanced by the pull of the opposite or top pole, which has an equal amount of magnetic pull at the same instant, thus neutralizing the effect of the bottom pole pulling downward on the armature.* The weight of the armature, shaft, flywheel and eccentrics is practically the only downward pressure imposed on the bearings.

It is not mentioned in the article whether the machine had a revolving armature or a revolving field magnet, or if driven by a horizontal engine or a vertical one. In all cases it is the object of the makers to use as small an airgap as gives safe clearance of the armature core. This varies but little between large and small machines and seldom exceeds ½ in. even in large machines, while motors of 5 to 10 hp. have an airgap of $\frac{3}{16}$ to $\frac{5}{16}$ in. If a vertical cross-compound or triple-expansion engine were used and two adjacent polepieces on the top side of the frame had to have jumpers put on to cut out the burnt coils without cutting out the opposite poles on the bottom, there would be more pull on the bottom than at the top of the armature.

This, in addition to the weight of the connecting-rods, crossheads and pistons, might produce the effect described. But I fail to see how properly designed boxes with good babbitt or bronze liners could wear down in three weeks. With such rapid wear there would be such excessive heating of the bearings as to melt the babbitt before a day's run had been completed. On large machines adjusting screws are usually provided in the feet to raise or lower the field frame so as to keep the armature in the center of the pole-face circle.

The location of the field coils cut out of service would have much to do with the stability of the machine, but cutting out the bottom or top coils would not tend to cause unsteady operation. It further appears that the machine must have been operating alone on the circuit, or with the coils cut out it could not have been put in parallel without cutting out opposite coils in the same series, thus reducing the capacity of the machine about one-fourth or to 24 poles. If the opposite poles of a revolving-field machine were not jumped or cut out, the vibration might be serious and possibly cause the destruction of the machine.

I can account for such wearing of the boxes only by assuming that the engine was a vertical one with very poorly adjusted valve-gear on the crank ends. It has been known that even horizontal engines with valve-gear out of adjustment have caused pillow-block bearings to heat, and I dare say this condition had more to do with the rapid wear of bearings described by Mr. Clapper than the unbalanced airgaps. Many machines are in daily use with unbalanced airgaps.

R. A. CULTRA.

Cambridge, Mass.

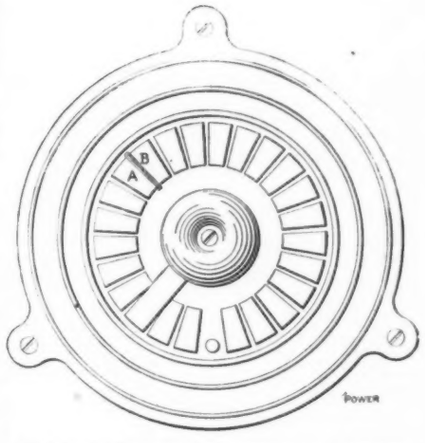
*Mr. Cultra overlooks the fact that with unbalanced airgaps the magnetic flux is not the same under all pole faces. The flux density is very much higher under the pole nearest to the armature than under the opposite pole and the difference in magnetic pull is even greater, because the pull is roughly proportional to the square of the density.—Editor.

A Quick Repair of a Rheostat

Our lights went out one cloudy day, and an examination proved the trouble to be a burned-out section in the rheostat of the dynamo.

I could not get at the wire without removing the rheostat from the switchboard, which would have taken too long, as we needed the lights badly.

I tried cutting out the resistance until



CONTACT PLATES TEMPORARILY BRIDGED

the contact finger on the revolving arm was beyond the damaged coil, but this let the voltage run too high for safety to the lamps, so I doubled a piece of 10-ampere fuse wire and drove it between the segments *A* and *B* (see accompanying sketch), to which the broken section was connected.

This temporary repair answered the purpose nicely until I could get a chance to take the rheostat down and make a new coil.

EARL PAGETT.

Coffeyville, Kan.

Gas Power Department

Worth-while gas-engine and producer information treated in a way that can be of practical use

A Successful Peat Gas Power Plant in Ireland

According to our British contemporary, *Engineering*, a peat-gas plant has been working in Ireland since September last, with results which are reported to be quite satisfactory. The plant is in the textile factory of H. Robb, at Portadown, and has replaced a Mond-gas plant by which power was formerly provided. The producer gasifies peat which is simply air-dried, cut from bog lands at Maghery, and stacked for the summer. As cut, the peat contains about 85 per cent. of moisture, and during an average season this can be reduced by air-drying to 26 per cent. In exceptional years, such as that experienced this last summer, peat can be dried in this district to about 19 per cent. moisture.

The plant is guaranteed to work with peat containing up to 45 per cent. moisture. It consists of two producers of 200 brake horsepower capacity each, with a coke-filled wet scrubber, a tar extractor, a sawdust scrubber, an exhauster and an expansion box. The air-dried peat is fed in block form, as cut, into a hopper above the generator, whence it falls into the generator itself as combustion proceeds. The gas is drawn off through the wet scrubber and washer to the tar extractor, where the tar is taken out by centrifugal action. It then passes on to the sawdust scrubber and is delivered to a gas holder by the fan which draws it through the producer. The gas produced has a value of about 140 B.t.u. per cubic foot.

As originally designed, the coke-filled scrubber became clogged with tar, and it was therefore modified so that the greater part of the coke was removed, and a water shower introduced, against which the gas passes upward.

The cost of the peat delivered at the works is 6s. per ton, and with an average load of 275 brake horsepower on the plant the consumption is found to be slightly under 20 tons, costing practically £6. There is a ready market for the tar at 35s. per ton, and about 5 per cent. of this byproduct is recovered from the plant, or about 1 ton per week. The net expense for fuel is £4 5s. per week. On the other hand, the anthracite used by the Mond-gas plant (8½ tons per week) cost £13 16s. 3d. The plant has not been running sufficiently long to ascertain definitely whether or not a slight increase in labor may be necessary; but allowing £40 per annum for such a contingency under these conditions at a factory of 500 looms, employing from 500 to 600 hands, a saving in the fuel bill of about £438 would result.

The operation of the plant is reported to be very simple, and after overcoming in the early stages one or two rather unexpected difficulties, of which one was due to sand becoming mixed with the peat during a long, dry summer, no further trouble has been experienced. The plant was designed and constructed by Crossley Brothers, gas-engine builders.

The Junkers Oil Engine

By F. E. Junge

Of the various internal-combustion engines which are competing with the steam turbine for preëminence in the field of large-scale economic power production and ship propulsion, the Diesel engine so far has been the only one to deserve serious consideration. Of late a new type of large oil engine is attracting attention in Germany; this is a two-stroke engine, built to the design of Prof. Junkers, of the Technische Hochschule of Aix-la-Chapelle. A freight vessel to be equipped with this type of engine has been ordered from the Weser Co., of Bremen, by the Hamburg-American Line. The power developed by the two engines is to be 1600 shaft horsepower. A 200-hp. experimental engine gave the data for the construction of a 1000-hp. engine which is now undergoing tests at Aix-la-Chapelle; Fig. 1 is a picture of this latter engine. The general arrangement of the parts of this tandem horizontal engine is shown in Fig. 2. Two pistons work in each of the tandem cylinders; the extreme forward and rear pistons act on the middle crank and the two intermediate pistons act on the outside cranks, which are set at 180 degrees from the middle crank. The connection of the pistons which move together with each other and with the crossheads is made by transverse yokes and side rods, as will appear from the longi-

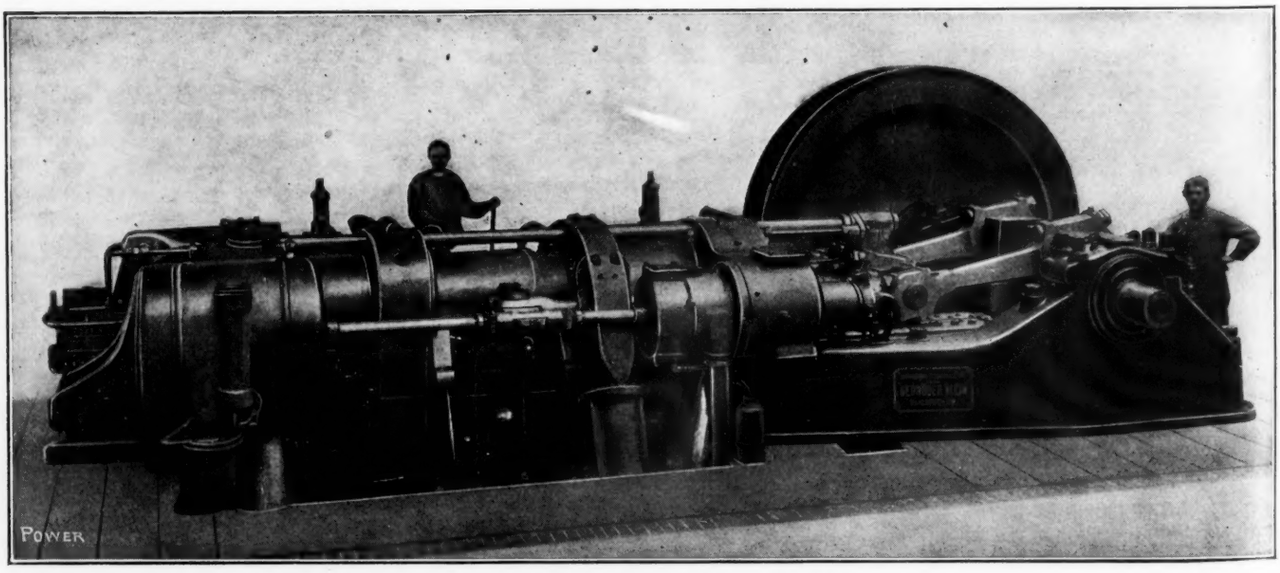


Fig. 1. Junkers High-compression Oil Engine of 1000 Horsepower

tudinal section and the elevation and from the schematic drawing, Fig. 3.

The engine works on the two-stroke cycle. While the pistons in one cylinder move outward on the working stroke, the pistons of the other cylinder travel inward, on the compression stroke. When the two pistons in one cylinder have reached the state of nearest approach, fuel injection commences; the two pistons in the other cylinder have then reached the position of greatest separation, and the expulsion of the expanded gases takes place, followed by an inward flow of scavenging air through ports at the other end of the cylinder from the exhaust ports. The ports are covered and uncovered by the pistons, eliminating all valves. The ends of the cylinders are open, each cylinder being the equivalent of two single-acting cylinders with their heads removed and their barrels connected at the head ends. The use of stuffing-boxes is thereby avoided.

The cycle of the Junkers engine may be more clearly understood by aid of Fig. 3, in which, for the sake of simplicity, only one cylinder is shown. At the innermost position *A* of the pistons, the combustion space, after a preceding compression stroke, is filled with highly compressed and correspondingly heated air; at this moment injection of fuel is begun. The fuel is forced in by compressed air and is in a finely divided condition; it ignites and burns under almost constant pressure during the first part of the outward stroke, from *A* to *B* on the indicator diagram. During the ensuing part of the outward stroke, the expansion of the products of combustion takes place, from *B* to *C*.

When the pistons have reached the position shown at *C*, corresponding to the point *C* on the diagram, the front piston *V* begins to uncover the ports in the cylinder wall through which the burnt gases escape. In the position shown at *D*, corresponding to *D* on the diagram, equilization of the cylinder pressure with that of the atmosphere has approximately taken place. In this position the rear piston *H* uncovers the rear ports and admits fresh air at low pressure, which drives the rest of the spent gases out of the cylinder through the exhaust ports at the front end. This process takes place while the pistons travel to the dead-center positions of the cranks and back to the position *F*, in which the pistons have closed their respective ports. At the point *F* the cylinder is filled with air alone and the compression of this begins; the inward travel of the pistons to the inner dead-center position completes the compression, giving the curve *FA* of the

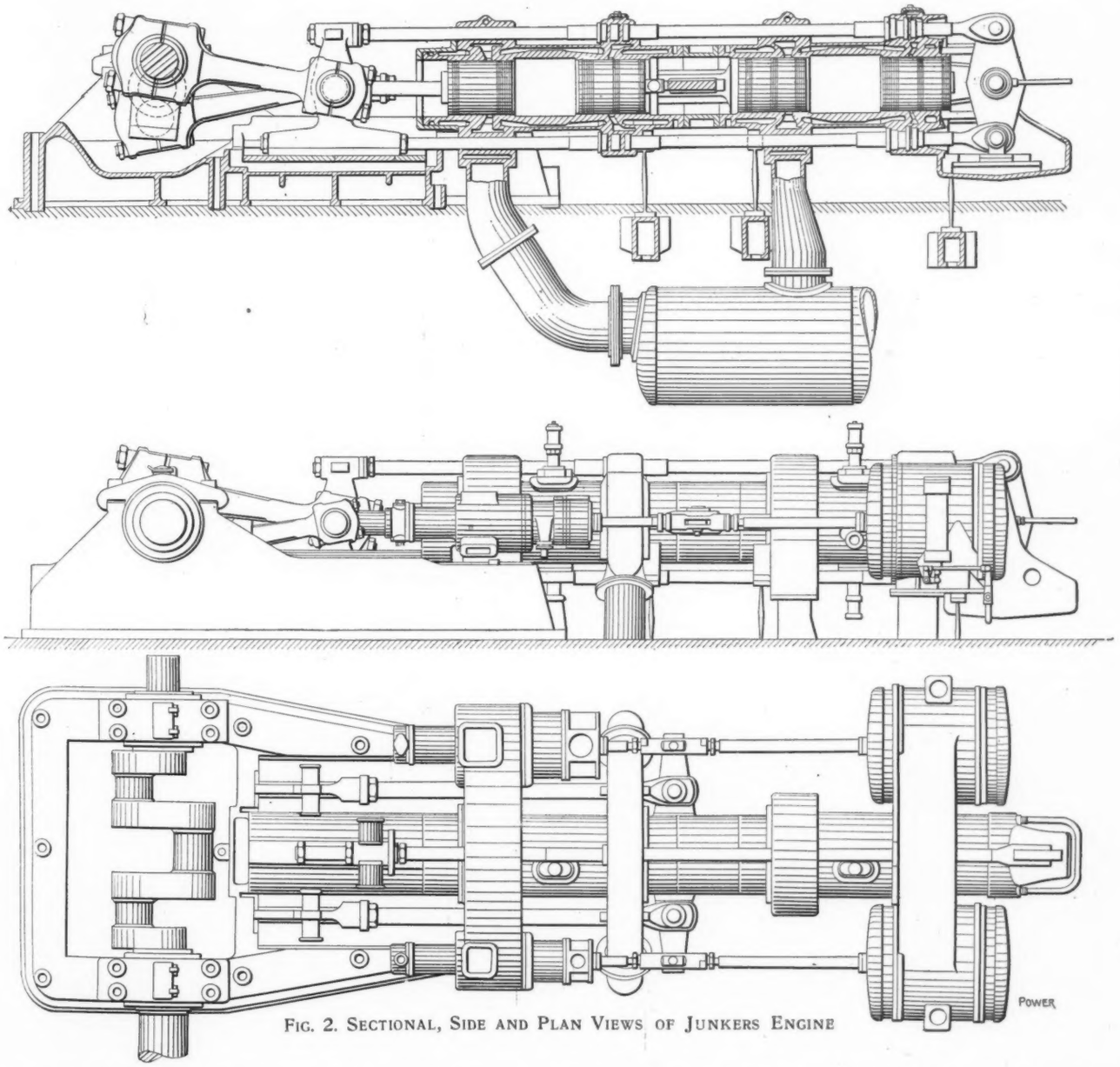


FIG. 2. SECTIONAL, SIDE AND PLAN VIEWS OF JUNKERS ENGINE

diagram. The compressed air becomes heated to such an extent that the fuel which is injected at or shortly before point *A* ignites, as in the Diesel engine, whereupon the working process just described is repeated.

The air pumps and compressors (in this case four-stage) which are necessary for the supply of the scavenging and fuel-spray air are arranged parallel to the work cylinders and their pistons are actuated from the yoke of the intermediate pair of power pistons. In large diameters each cylinder is provided with two fuel sprays and one compressed-air starting valve. The fuel-injection nozzle is so designed as to give the fuel oil a close contact over a large surface with the combustion air.

Action of Forces and Balancing

With regard to the action of forces and the balancing of the moving parts, the Junkers engine has a decided advantage over engines of the usual type, inasmuch as the free forces are completely balanced in the center line of the engine, neglecting the error due to the obliquity of the connecting-rod; while the main bearings, due to the opposition of the forces in the driving elements, are relieved from thrust loads.

Owing to the division of the total stroke between two pistons, a relatively small individual piston speed is attained at a high rate of revolution and a high effective piston speed, the latter being twice the actual speed of each piston.

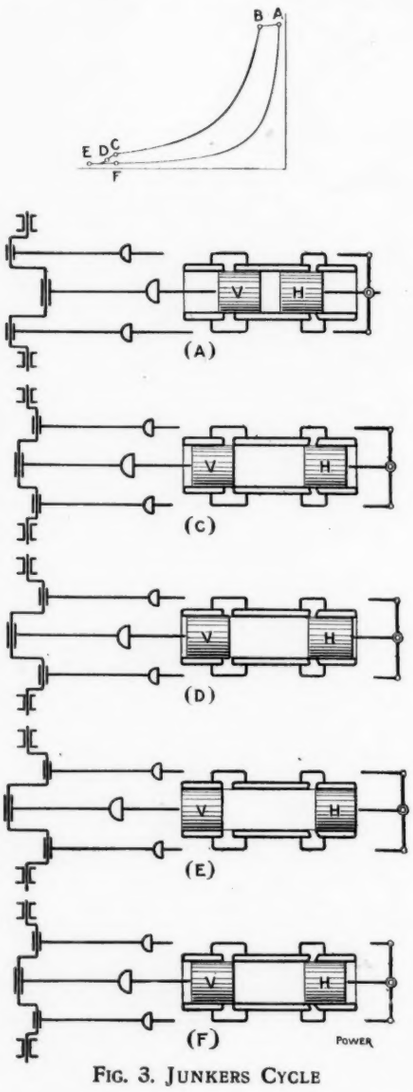


Fig. 3. Junkers Cycle

The general form of the Junkers engine for marine service is shown in Fig. 4. The cylinders, side-rods, etc., are arranged in exactly the same relative positions as in the horizontal engine, the only important changes being in the form of the main frame supporting the crankshaft and the method of mounting the cylinders. It is this type which will be installed in the Hamburg-American freight vessel.

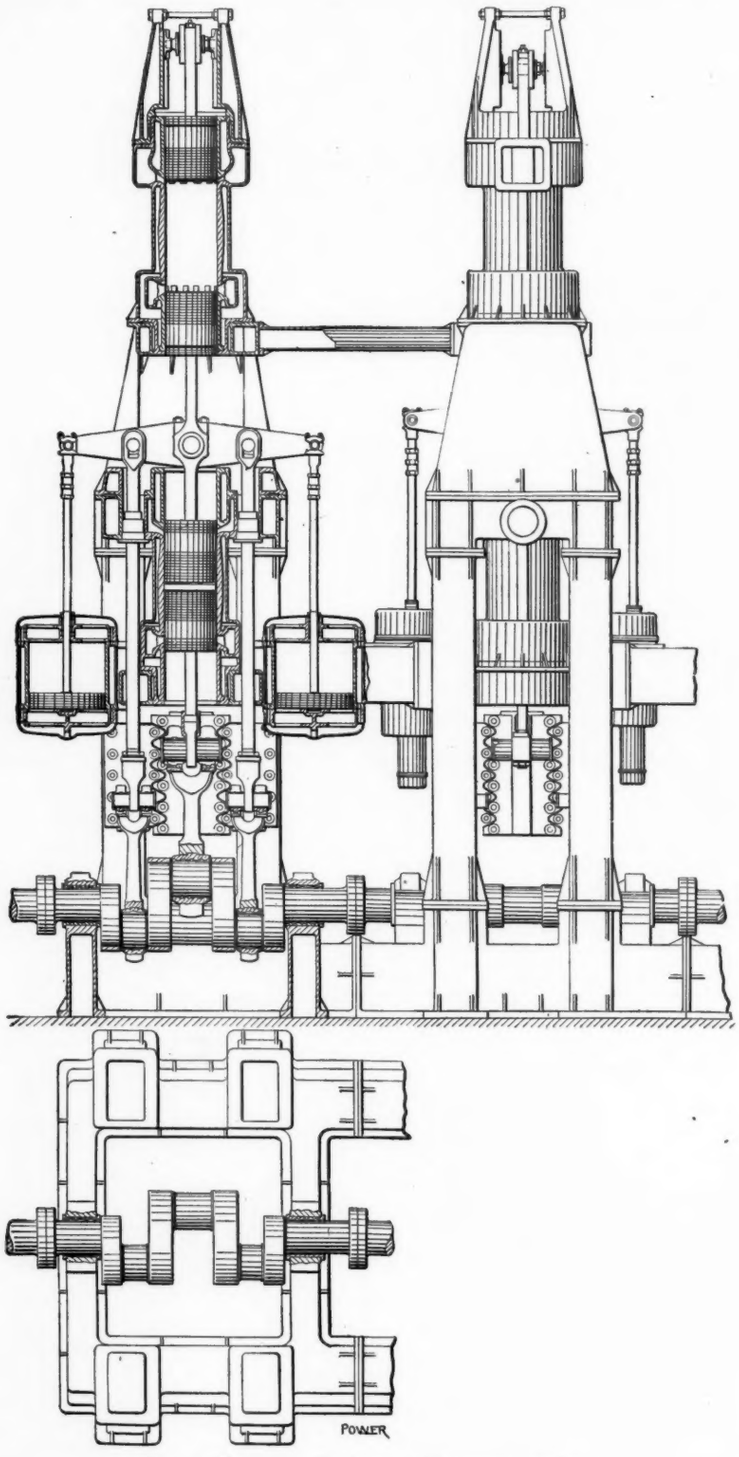


Fig. 4. Vertical Form for Marine Service

Refrigeration Department

Principles and operation of ice-making and refrigerating plant and machinery

Charging and Starting an Absorption Plant

By Walter C. Edge

In operating a plant of this kind many things, such as the detection and stopping of leaks, the withdrawal of permanent gases, etc., are done in the same manner as with the compression machine. Installation and testing of the apparatus are done by the manufacturer and will not be enlarged upon here.

For the sake of convenience the test is hydraulic, since this form of pressure can be easily applied with the ammonia pump. Having tested the apparatus to 300 lb. pressure, it is necessary to expel the air as in the case of the compression machine.

This may be done by the process of steaming out or the raising of steam in the generator, while the connecting valves as well as a valve to the atmosphere are open. Steam passes through the system and displaces the air which is expelled at the open valve. When the steam pressure is greater than that of the atmosphere and the air has been expelled, the valve is closed and the system allowed to cool, thus condensing the steam and creating a vacuum in the apparatus. If the pump is run while the system is under steam, hot water will be circulated to the different parts of the apparatus and will have a cleansing effect. When this is done, a valve is kept open to allow the dirty water and steam to escape to the atmosphere.

One objection to this method of getting a vacuum is the fact that the heat of the steam softens the rubber packing of the ammonia joints so that they may leak and must be tightened.

It is better to use the boiler-feed pump or the ammonia pump, by which means a vacuum of about 25 in. can be created. After pumping out the air to this extent, a drum of aqua ammonia is connected to the suction line near its connection to the ammonia pump. The vacuum will cause the ammonia to flow into the system, but care should be taken to close the stop valve as soon as the liquid has been drawn out; otherwise, air will be drawn into the system. As many drums as possible are charged in this way, but as soon as the vacuum is gone the stop valve on the suction line must be closed and the ammonia pump started to force as much additional ammonia liquor into the system as is necessary.

Steam is now turned on the coils in the generator, and the ammonia is slowly heated until the gage shows about 100 lb., at which time the purge valve is opened and the discharge led into a pail of cold water until air bubbles cease to appear. Cooling water is now turned on the condenser and absorber, and, after the distributing valve to the freezing tank is opened and the weak liquor turned into the absorber, the ammonia pump may be started to pump the rich liquor through the equalizer to the analyzer.

When the air is out of the system and the expansion coils have become coated with frost, the machine is shut down and the freezing tank is filled with brine. If necessary, more ammonia may be put into the system by connecting the drum of anhydrous ammonia direct to the cooling coils and allowing the ammonia to expand direct to the system. It should be remembered that ammonia expands when heated, so that if a full charge is put into the system while cold, there will be an overcharge when everything is warmed up under working conditions.

When the cycle of operation is well under way, liquid ammonia should appear in the receiver, and any deficiency in this regard should be made up by supplying anhydrous ammonia to the system, or by adding strong aqua ammonia and withdrawing a corresponding amount of the weak liquor.

In addition to the inevitable leakage of air into the system, permanent gases may be produced by the decomposition of ammonia and from other causes. To prevent pitting of the steam coils in the generator, they should be covered with from 4 to 6 in. of ammonia liquor.

The capacity of an absorption machine is determined by the pressure in the steam coils of the generator and the amount of liquor circulated from the generator to the absorber. Pressure in the steam coils fixes the temperature, and this in turn determines the amount of ammonia distilled. With the horizontal machine and a condensing pressure of 150 lb. the steam pressure is about 50 lb. With the vertical type of machine the pressure is determined by the operator in such a way as to prevent boiling over. Leaks and the processes of boiling and siphoning over are the principal causes of trouble in absorption machines.

Poor work is detected by noting the thermometers and pressure gages, and the remedy suitable to the trouble must be applied for each particular case. Here, as in every other line of work, an ounce of prevention is worth a pound of cure, and the engineer who is on the alert to detect any unusual indications of his gages is the engineer who will have no troubles to overcome.

Properties of Ammonia

By F. B. W. Barker

Ammonia is chiefly obtained as a by-product in the distillation of coal for gas or coke. It is also obtained in the destructive distillation of organic matter containing nitrogen, such as animal matter and residues from the manufacture of beet sugar and the fermentation of molasses for alcohol. Bituminous shales and waste gases from blast furnaces are also sources from which ammonia may be extracted. Ammonia can be made from the nitrogen in the air, but the process is not economical and is therefore commercially unimportant.

The gas liquor from the hydraulic mains and scrubbers of illuminating gas plants furnishes the bulk of the ammonia used in refrigeration. The destructive distillation of coal causes the main portion of its nitrogen content to be converted into ammonia and cyanogen compounds. The chief ammonium salts which are volatile with steam are the carbonate, sulphide and sulphydrate. The other salts which are not volatile with steam are the sulphate, thiosulphate, sulphite, sulphocyanide and ferrocyanide. These salts with free ammonia are found in gas liquor.

The tar in the gas liquor is allowed to settle, and the volatile ammonia salts are driven off by heating in a still with steam, and the liquor is treated with milk of lime in another still and heated again until the ammonia is driven off the fixed salts.

The common ammonia of commerce is a solution of ammonia gas in water and its usual strength is about 26 deg. Baumé. Anhydrous ammonia is dry ammonia gas compressed to a liquid, and is manufactured by the distillation of the 26-deg. ammonia of commerce. The apparatus consists of a still, condenser, separators and a drier. The still is heated to 212 deg. by a steam coil, when the ammonia gas, with some of the water, is driven off and passes into the first separator, which usually forms an up-

ward extension of the still. A greater portion of the entrained water is separated from the gas in this separator by passing the gas through a series of perforated plates and the water is returned to the still. The partly dried gas is passed through a condenser, and then through two other separators to the drier, which has perforated plates, similar to the first separator. Upon these plates are placed lumps of unslaked lime. The lime absorbs any moisture which may still remain in the gas, which is then pumped into the shipping drums.

A pressure of about 30 lb. per square inch is maintained on the still, so that the temperature may be raised a little higher than 212 deg. without causing the water to boil. In this way almost the entire amount of ammonia gas is liberated with the least amount of moisture.

Commercial 26 deg. Baumé ammonia contains 38.5 per cent. of anhydrous ammonia. The latter has a molecular weight of 17 and a density of 8.5. It boils at 40 deg. F. below zero at the pressure of the atmosphere.

Gaseous ammonia can be liquefied at a pressure of 128 lb. per square inch and a temperature of 70 deg. F. At a temperature of 77 deg. F. the pressure must be raised to 150 lb. It is thus apparent that the pressure required to liquefy ammonia rises rapidly with the temperature.

Ammonia gas can be liquefied at a temperature of —85.5 deg. F. At 32 deg. F. one volume of water will absorb 1049 volumes of gas and at 60 deg. F. 730 volumes are absorbed.

Ammonia gas has an injurious action on copper and copper alloys, so that these metals are not used in the construction of any part of an ammonia system. Owing to the searching nature of ammonia gas, it is very troublesome to deal with, even at low pressure, and this trouble is greatly exaggerated at the comparatively high pressures maintained in the compression system. The liability of leakage at the stuffing-boxes and other parts of the system, is one of the objections to the use of ammonia gas as a refrigerating agent, particularly for marine service. It is thus by no means a safe refrigerating agent, and, where used, more than ordinary precautions should be taken to prevent accidents. It is a colorless, irrespirable gas. The irritant and pungent odor makes the repairs of a part of the system confined in a room or location where the ventilation is imperfect a difficult operation. Helmets of leather or other material, somewhat like a diver's helmet, attached to a portable tank containing air under a pressure of from 60 to 100 lb., and carried by a strap slung over the shoulder of the operator, are provided in well regulated plants, to be used in an emergency. As the weight of the gas is only half that of the air, it will tend to rise when escaping from a leak, so that a person who happened to be near at the time of the accident should keep as near to the floor as possible when escaping from the premises. A person rendered unconscious by an overdose of ammonia gas should be revived by means of artificial respiration, similar to cases of drowning. Liberal quantities of vinegar or lemon juice in water should also be given to the patient.

The chief advantages of anhydrous ammonia as a refrigerating agent are that it liquefies at a comparatively low temperature and that it has the greatest heat-absorbing power of any of the other agents.

Ammonia is combustible. When mixed with the proper proportion of air it will burn feebly, with a greenish yellow flame. If mixed with about 2.5 times its volume of air it is capable of exploding with considerable violence. It is absolutely dangerous to insert an open flame into any part of the system after opening for repairs or inspection. Sufficient time should always be permitted to elapse to permit the ammonia to become dissipated.

The presence of permanent gases (bad gases) in the system reduces the efficiency of the plant, by decreasing the capacity of the condenser coil, requiring either more cooling water or a greater pressure in the condenser. Air drawn into the system through leaks, when pumping a vacuum, in the low-pressure end of the system gives the most trouble. Nitrogen and hydrogen are also formed, due to the decomposition of ammonia by excessive heating during compression. These gases are removed by opening the purge valve located at the condenser or the highest point of the system. A hose should be attached to the outlet of the valve and the end immersed in cold water. The valve should be kept open as long as air bubbles escape to the surface of the water. A crackling noise in the water indicates that ammonia is escaping and the valve should then be closed.

LETTERS

Temperature of Ammonia Discharge Pipe

I noticed in the Dec. 12 issue an article by D. E. Aden on the above subject. I agree with him that it depends on whether a dry- or wet-gas machine is used.

In a wet-gas machine the temperature of the discharge pipe depends on the amount and strength of the charge and the distance that the engineer wishes to freeze back. A live charge will gather more heat from the tank per pound of liquid admitted than an old charge ladened with aqua and oil. Thus the distance of freezing back on the suction side of a machine is greater for the former than for the latter. Some machine builders advocate a hot discharge and others think that it should be lukewarm. For my part, I think that the temperature should not be above 170 to 180 deg., and even this is a little high for the good of the charge.

In one plant in which I was assistant, the hot side was run luke-warm, and we got 40 tons from a 30-ton tank. In the plant in which I am now employed there is a 20-ton tank, single-pipe condensers and the temperature of the circulating water is 90 deg. We get 26 tons per day for as much as seven days, and then 24 tons for a few days more. The point that I wish to bring out is that, with a good live charge, by running the discharge pipe just hot enough so that I cannot hold my hand on it for over two seconds, even if the frost is crawling over the heads a little, I can get by far the best results and can hold the tank temperature better.

In the first plant mentioned the frost line had to be held back to the edge of the valves. I also found that I got a great deal of aqua or "dead juice" from this system. Could this have been caused from overheating? I would like to hear from readers of POWER on this point and would also like to know at what temperature does ammonia precipitate.

BENNETT STORY.

Kingfisher, Okla.

Fire Precautions for Steel Stacks

In its statistics of fires in electric-light and power stations the National Fire Protection Association reports that six out of eighteen fires were caused by the wooden-roof construction igniting from the lack of protection from the heated steel stacks.

It is advocated that free air space should be provided entirely around a steel stack and that the stack should be protected by a steel-plate umbrella attached to it some distance above the roof opening and spreading out so as to protect it without touching the roof. A cylindrical sheet-steel ring projecting above and underneath the roof should be placed around the opening for the chimney.

A well known fire-insurance concern in Boston, which has been carrying on investigations into the causes of fire in boiler plants has suggested that fires may occur from rapid corrosion of the stacks due to condensation of the acid products of combustion near the roof line. This inside corrosion will in time provide small holes for the sparks which are usually the beginnings of fire on boiler-house roofs.

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POWER

Old Boilers Are Dangerous

The two boiler explosions which have occurred recently in New York City, while resulting in no loss of life and with but slight property loss, when compared with what might have been, point out the lesson that old boilers should be discarded before they become unsafe.

Both of these boilers were old, and they were carrying as high a steam pressure as would have been considered safe several years ago.

The deteriorating action, due to long usage, gases and contraction and expansion, may have been considered to some slight extent when the boilers were inspected, but good judgment is necessary in ascertaining just how much a boiler has deteriorated and how far the deterioration should be allowed to continue before the boiler is condemned.

A boiler may become unfit for use in a few years if it has been abused; a similar boiler may be in apparently good condition at the end of twenty years. There comes a time, however, when a boiler, like an old and faithful horse, should be retired upon general principles. Just when that time comes is a question, but surely, a boiler which has been in constant use for thirty-two years has passed the age of safe operation, especially when cast iron enters into its construction.

Cast iron is a treacherous metal and utterly unfit for boiler construction, and boilers in which this metal is used should be debarred from high-pressure service.

There are doubtless many boilers of questionable age in operation in every large city which should be condemned.

It is poor practice to pass a law compelling engineers to pay for a license to operate steam boilers in order that the public shall be protected against accidents and then to permit old, decrepit boilers to be operated after they have reached a ripe old age.

The best engineer in existence cannot make a boiler thirty-two years old safe, but a boiler-inspection department can make the owners put in a new and much safer boiler. Will they do it?

Accessibility in Modern Power Plant Design

In comparing a typical, uptodate power plant with that built twenty or twenty-five years ago, one is impressed (next to the increased capacities of individual units) with the attention given to general accessibility, light and ventilation. Formerly, these requirements were considered as of very secondary importance, and the building was usually made only large enough to house the necessary apparatus. Now, however, they are considered among the prime considerations of good design.

While the concentration of large power into comparatively small-sized units and the generally recognized necessity of providing for future extension may have had some influence, still they would have been offset to some extent by the increased value of property. Therefore, one must look further to account for this tendency in present practice. Undoubtedly, it is due to a recognition that better operating results are thereby attained.

In the first place, accessibility and light permit better work being done when making repairs. How many engineers can recall the discomfort and hindrance encountered in packing a valve placed on top of a boiler, where there was scarcely any headroom and practically no light, not to mention the total absence of any ventilation; or, again, in making repairs to a pump poked away in some inconvenient corner or close to a wall?

Under such circumstances, it is impossible to expect good workmanship and the effect upon the operating force is not conducive to good results. Moreover, an excuse will often thus be furnished for letting apparatus run without the necessary attention and minor repairs until a breakdown occurs.

Again, a light plant furnishes none of those dark corners which are so apt to serve as a convenient place for the accumulation of rubbish. But perhaps one of the greatest advantages of having all piping and apparatus easily accessible is that in cases of emergency the proper valves, etc., may be got at with greatest haste and usually with least danger.

The Card Abstract

An exceedingly useful and valuable habit, which may be acquired both by the beginner and by the experienced engineer as well, is the making of short abstracts not only of the articles appearing in the leading engineering journals but also of the material to be found in engineering books. Such a habit is the assurance to the reader that his reading is not superficial. We read our engineering journals in order that we may keep up to date; but too often our reading is a mere skimming, a habit which we have unfortunately contracted in reading our Sunday newspapers.

There is scarcely a person interested in any way in mechanical engineering who does not have his hobbies. These may be related to the work which he is doing every day or they may be a side issue. For instance, many steam engineers, while endeavoring to keep in touch with subjects related to steam engineering, are also very much interested in gas engineering. The short abstract offers such a man a method of collecting from different sources information along these various lines and compiling it into a more or less harmonious whole.

The short abstract has the advantage over the filing of clippings in several respects. In the first place the journal from which the abstract is taken is not mutilated. In the second place, inasmuch as a clipping may be filed without more than merely reading the heading, the abstract, since it requires a careful and assimilative reading, is in most cases much more likely to make a lasting and valuable impression. In the third place it is not necessary when consulting the abstract to read through the whole mass of the article in question as only the essential points are recorded.

The card abstract is mentioned because cards are a very convenient and effective means of collecting and filing such information. They are inexpensive, several hundred cards costing only a few cents. The filing box of cardboard may be purchased for a very small sum while, of course, more elaborate ones may be had. The card collection is very flexible and cards may be added or removed practically without limit. The cards are portable and enough cards for several hours' work may easily be carried in an envelope. The loose-leaf notebook possesses many of the same advantages which the card collection has. However, it is usually a little more expensive and is not quite so flexible in that it is limited as to size.

The first step in abstracting a paper is to note down the title and the location of the article so that reference may be had to the original if it should become desirable or necessary. The author's name, the date, the page and the name of the journal should all be carefully noted. Especial care should be taken in abstracting an article to be concise and yet thorough. The purpose of the abstract should be kept clearly in view from the beginning. An abstract is usually made so that the information which the original article contained may be put into a more convenient and usable form.

In abstracting most mathematical studies it will not be found necessary to abstract the whole of the argument. Care should be taken that the mathematical discussion is thoroughly understood and that the conditions of the application are quite clear; then only the results need be recorded.

An abstract is not necessarily a copy. Most technical articles as written contain a large amount of descriptive and explanatory matter which may be dispensed with after the first reading. The meat of a whole paragraph may often be expressed in a very few words. In order that this may be done intelligently, it is apparent that a complete and exact understanding of the subject matter is essential. It does not require much intelligence to copy, but an abstract cannot well be made without a process of careful thinking. When experimental results or empirical data of any form are given the only way to record them in the abstract is to copy them, but in no other case is copying justified.

A series of these abstracts upon related subjects will be a valuable personal possession. Not only are the abstracts themselves useful but the vision acquired in making them is a valuable and lasting asset.

Running a Steam Turbine

In the Dec. 26 issue of POWER there was offered a prize of fifty dollars in gold to the man who, before Mar. 1, submits the best practical article treating of the above subject.

Most of the available literature on the steam turbine deals with principles, type differences, efficiencies, etc. What is needed by the stationary engineer is a working knowledge of the functions of a steam turbine, how to make it run and how to keep it running.

That the turbine is in the field to stay is evidenced by the fact that three manufacturers in this country have put out some five million kilowatts, the bulk of this in the past six years. In England alone, 6½ million horsepower has been made, nearly two million of which belonged to the period 1910-11, according to the recent statement of a well known English concern.

Responses to our invitation have begun to come in, but we want more of them.

It requires no literary training, no command of classic style or wide vocabulary to place on paper a clear, brief story of how a practical engineer should run a steam turbine. Just get the ideas into it and we will furnish the style.

Do not be deterred either from illustrating your article because of the difficulty of making the drawings; a rough sketch—such as you would draw if you were describing the apparatus or process to another engineer—will suffice; anything that our artist can interpret.

The article must be in our office before Mar. 1, and for equal merit priority in time will count.

Is New York City about to undergo an epidemic of boiler explosions? Two recent explosions have occurred in which the boilers were old enough to have been retired.

There will be some humidity in the atmosphere around the Delray station of the Detroit Edison Company if a tube splits in one of those 2365-horsepower boilers.

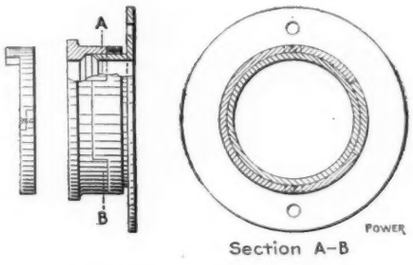
If for no other purpose than to indicate when to clean fires, draft gages are good things to have attached to the boilers.

Readers with Something to Say

A letter good enough to print will be paid for. Ideas, not mere words, wanted

Stuffing Box Repair

We have a duplex, outside-packed feed pump with a cavity in the stuffing-box shell as shown. What this is for I do not know, but I do know that it is difficult to get the packing in past it, and impossible to keep it there any great length of time. The stuffing-box is very short and in order to improve it I sawed out a mold and poured babbitt metal, making a ring with a projection



How Stuffing Box Was Repaired

as shown in the two views on the left. I put this ring in for an extension of the stuffing-box, the projection on the ring filling the cavity in the stuffing-box. I have no more trouble putting or keeping the packing in.

I made the rings in two pieces so I could put them in without taking out the plungers.

F. W. Bair.

Hancock, Mich.

Clearing a Fouled Feed Line

I was hurriedly called out one night by the night engineer in our plant; as he could not get any water into the boiler. The feed pump seemed to be working all right but it was injecting no water. Our feed water is just as hot as the pump will handle it. I tried the injector, but it would not work, and as it fed through the same pipe as the pump, I concluded that there was some obstruction in the feed pipe between the pump and the boiler. On taking off the head of the water end of the pump I found that the packing was all gone. I then knew what was in the heater and feed pipes.

The night engineer started to put in new packing and I began to think out some way in which to get the old packing out. I first broke a joint in the pipe next to the pump. Then I went on top of the boiler and shut the stop valve on the feed line, hoping it would be tight. Next I took the cap of the check valve off, took out the valve, put the cap on again and then opened the stop valve. Luck was with me, for nearly a peck of chewed-up packing was blown out of the pipe.

I put the check back, made up the joint that had been broken, and by that time the pump was repacked. When it was started it worked all right. It took us just 30 minutes to get running again. Since then I have put in packing that cannot be harmed by hot water.

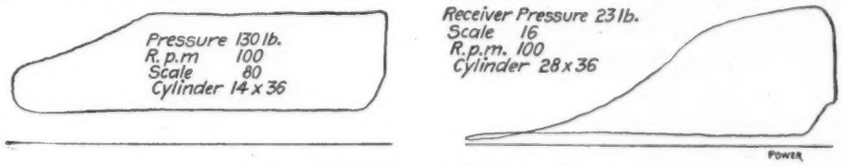
An ice plant not far from ours had the same trouble, and they were two days cleaning out the pipes and heater.

Frank H. Cordner.

Bradford, R. I.

Engine Load Not Equalized

The accompanying diagrams were taken from a 14 and 28 by 36-in. engine which has just had the valve seats bored out and new valves supplied. The engine is noncondensing.



Diagrams Showing Unequal Load

I cannot get the cylinders to take the load equally. I would like to have Power readers tell me what changes are to be made in the valve setting, and what causes the hook on the low-pressure diagram.

Harry H. Gordon.

Amsterdam, N. Y.

Copper Crosshead Shoes

Engineers often find that the crosshead shoes wear very fast under some conditions. For the benefit of any who have that trouble and who seek a remedy, I would advise using a copper shoe in place of the babbitt.

The first time I saw a copper shoe was when I took charge of a new plant of several engines, all of which were fitted with copper shoes. I expected to have trouble with them, but I found they prevented trouble. After the plant was running about six months, I installed another engine, alongside one that was running, and in putting in the concrete foundation some of the concrete got onto the guide, and fire was flying in all directions, but by putting on a liberal supply of oil the guide was soon cooled and no damage was done to the shoe; I did not even stop the engine. If this had been a babbitt shoe it would have been ruined.

C. L. Johnson.

Newark, N. J.

Illustrating Need of License and Inspection Laws

There is an old saying that a special Providence watches over greenhorn sailors and drunken men. To this I should like to add, "and men in charge of steam boilers." Occasionally we hear of a boiler bursting with disastrous effects on men and property, but this I do not suppose is due to any lack of vigilance on the part of the aforesaid Providence so much as to the extreme limit of endurance to which He must be put most of the time.

The above remarks are made not through any malice, but because contact with the outlandish conditions met with in plants in some sections of the country while acting in the capacity of boiler inspector clearly indicates the necessity of regulation by law. This necessity is made apparent by the following, which describes rather extreme conditions I will admit, but which goes to show to some extent the possibilities that exist.

I visited the city pumping plant of a small municipality not long since, being interested in such plants. Here I found an old negro in the capacity of chief engineer. His boiler plant consisted of two locomotive-type boilers. A 3-inch header connected the domes of both with one lever safety valve. There was a stop valve between each dome and the safety valve. For some reason or other, probably because of the leaky condition of the safety valve, a piece of 2x4-inch pine was tightly wedged between the end of the lever and a rafter, thereby putting the valve out of business.

No gage cock or water glass was in evidence. The only information as to the hight of the water was furnished by two leaky brace rivets in the head which were blowing constantly. When I asked

how much steam he carried, the darky replied with the enthusiastic manner of the average colored "chief engineer:"

"When de clock han' gits straight up and down, why den I opens de doo', an' ef hit sots dar too long, boss, I keeps dis heah barrel of watah close by so dat hit will be handy, an' I puts some on de fiah."

If such conditions do not call for regulation by law and competent supervision, I am willing to quit.

H. CLARK.

Punxsutawney, Penn.

A Nonleaking Blowoff

To prevent a leaking blowoff I put a globe valve next to the boiler and then a gate valve. When not in use, both are closed.

When blowing down the water in the boiler, the gate valve is opened wide; then the globe valve slowly; the gate valve is then slowly closed, after which the globe valve is closed. Then the gate valve is opened to let out what scale and water remains between them. The gate valve is then shut tight.

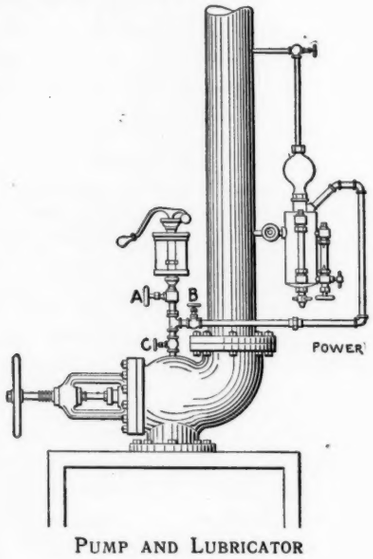
By this method there never is any small scale caught under the disk of the globe valve, and a leaky blowoff is unknown.

O. B. HALE.

Warren, Ohio.

Oil Pump and Lubricator Filler

In the accompanying sketch is shown a method of using a common cylinder-lubricating pump either as a lubricator filler or a cylinder-oil pump.



PUMP AND LUBRICATOR

The pump is mounted on a tee with the side outlet piped to the filling hole in the lubricator, while the run leads to the cylinder. When it is desired to fill the lubricator the valves *A* and *B* are opened and the oil is pumped directly to it, the water in the body and condensing chamber being let out through the drain cock, while by closing *B* and opening *C*, oil may be pumped directly to the cylinder.

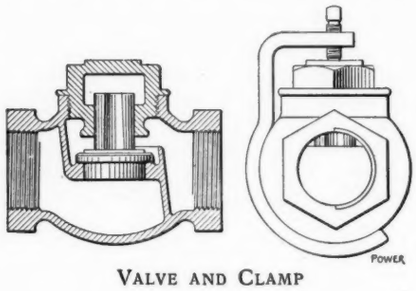
MARTIN MCGERRY.

Holley, N. Y.

Quick Check Valve Repair

In one of the plants under my care a little trouble with a check valve on a line of water pipe made quick action necessary.

The cap which acted as the stop for the valve itself was not tight, and in



VALVE AND CLAMP

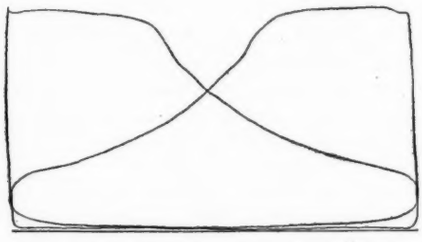
endeavoring to make it so the thread was stripped. There was no time just then to put in a new valve, so it was fixed up very simply, and at the same time effectively, as shown in the sketches. A clamp, which was made of ⅜x¾-inch iron, with a ⅜-inch setscrew, was put around the valve. With a gasket under the cap the pressure from the screw held the joint tight until the valve was replaced about a year later.

H. W. HANKIN.

Troy, N. Y.

Reduced Angular Advance

The accompanying indicator diagram was taken from a 14x36-inch engine, running 120 revolutions per minute. This engine had a pound that occurred when the crankpin was about 13 degrees below the head-end center, which I was unable to get rid of by taking up on the



FROM A QUIETLY RUNNING ENGINE

bearings and boxes, so, just as an experiment, I decreased the angle of advance and the knock disappeared as if by magic. If I increase the lead or the compression the pound will appear, so I have practically cut out the compression; it will be seen that the admission line leans inward a little.

The engine runs quietly at all loads, and will carry a heavier load than before, because the decreased angle of advance makes a later cutoff possible. This is a good thing, as the engine carries a very heavy load all of the time.

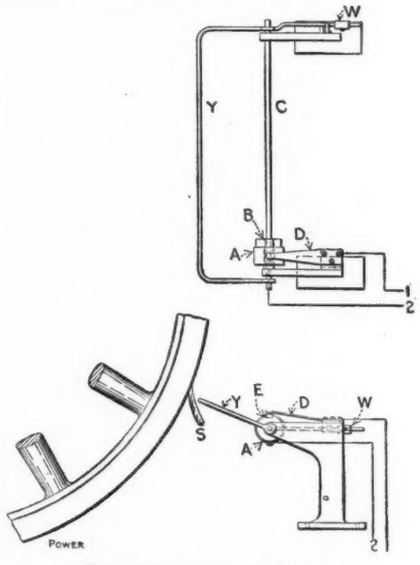
GEORGE DREYER.

Gibsonburg, Ohio.

Rope Drive Safety Alarm

In a plant I recently visited there were three rope drives, one from the engine to a jackshaft and one from the jack to either side to two line shafts. The drives were of the American type and had been in continuous operation for seven years without a break.

The one man in the plant had to be in the boiler room most of the time. The engine and boiler rooms were about 30 ft. apart with a room between them, and through fear of the ropes breaking while he was away, the engineer rigged up an alarm device. The arrangement is shown in the accompanying sketch.



DETAILS OF THE ALARM

A wooden piece *B* is put on the axis *C* and the brass piece *A* forced over this wooden piece, making *A* insulated. The piece *A* has a piece of wood *E* inserted in the circumference; and *A* is put on the axis in such a way that the spring *D* comes in contact with *E* when the arm *Y* is in its normal position. This keeps the circuit open. One wire of the circuit, No. 1, is attached to the spring *D*, and the other, No. 2, is attached to the insulated strip *A*. The arm *Y* is counterbalanced by the weight *W*, making it easy to throw back. The current is supplied by four dry batteries, and two 6-in. gongs, one in the engine and one in the boiler room, are inserted in the circuit for the alarm.

When the rope breaks, the loose strand *S* hits the arm *Y*, throwing it back and

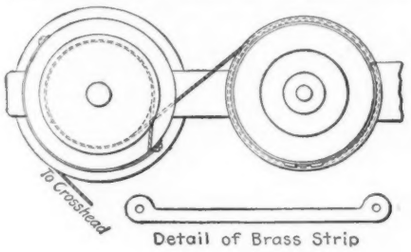
closing the circuit, by turning *A* around so that the spring *D* comes in contact with it and rings the bell.

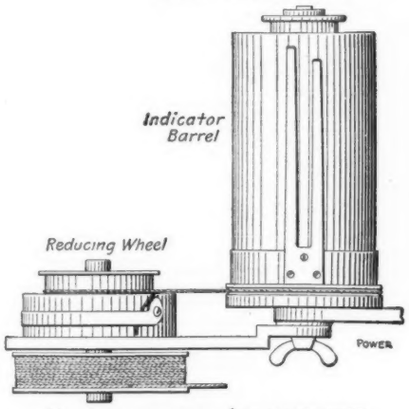
EARL L. LYON.

Oakland, Calif.

Reducing Wheel Cord Fastener

In some of the older types of indicator-reducing wheels an improvement may be made in the cord fastening by the use of a thin piece of sheet brass secured to





CORD-FASTENING ARRANGEMENT

the spring barrel by the regular cord-fastening screws, as shown in the sketch. In use the free end of the drum cord is passed between the strip and the barrel, close to one of the screws, which is tightened when the cord length is adjusted, the friction holding it securely.

This provides a quick and accurate method of getting the right drum-cord length and is especially convenient when very long diagrams are wanted, as the drum travel can be readily equalized between the stops.

A. H. BULLARD.

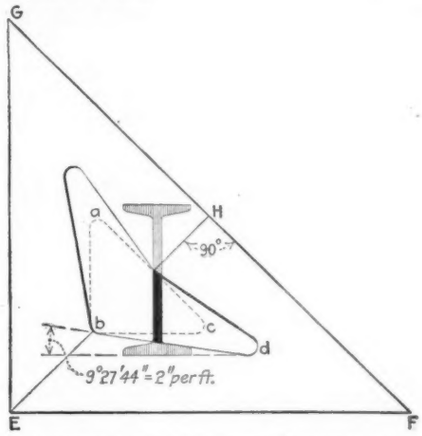
Syracuse, N. Y.

Improved Drawing Triangle

Draftsmen's triangles, as usually constructed, have a center hole or opening with edges that are parallel to the outside working edges, as shown in the sketch by the dotted lines *a b c*. This center opening is of no practical use other than perhaps to facilitate picking up the triangle from the drawing board.

Several years ago I had occasion to draw a number of sections of I-beams and channels and conceived the idea of making the inner opening of the triangle with edges having a slope of 2 inches per foot with respect to the outside edges so that use could be made of the inner edges when drawing the "shapes" just referred to.

Any draftsman, by using a little care, can cut his triangle to conform with the shape as shown. The time so spent will be repaid many times in the course of a year's work.



TRIANGLE FOR DRAWING STRUCTURAL SHAPES

Mention might also be made of the usefulness of a line, as *E H*, cut into one side of the transparent celluloid triangle.

Such a line will be found useful and convenient in drawing lines at right angles to each other in sketch work when no tee-square is used.

JAMES DOW.

Syracuse, N. Y.

Wanted: Engineer of Pleasant Disposition

The following ad appeared in a "Want" column of a Detroit evening paper:

"A competent engineer who is also a good fireman and of pleasant disposition. Address, O, box 5, News."

If one reads between the lines, he will find something like this: "Wanted, a handy man with an engineer's license who has not backbone or brains enough to stand up for his rights, but will smilingly trot along and do any old job the boss asks of him, and then run back and ask for more."

I have no doubt but that someone will go and take this job, for there is plenty of this type of engineer; it is this type that is keeping the engineers where they are in the eyes of the majority of employers. They do not know their business as engineers; consequently they cannot explain their duties to their employer and their responsibility in the engine room, and what a slight neglect on their part might cause. They do not get time to sit down and figure out ways and means of reducing the cost of power, or even to examine the equipment in their charge and keep it in decent working order.

It is in the plants of such men that one will find a tin pail hanging over the main bearing with a hole punched in the bottom and a stream of water running on the bearing, oil all over the floor, dirt all over the engine, and both all over the engineer. As a rule, it is this class of engineer who always kicks about the boiler inspector being too strict.

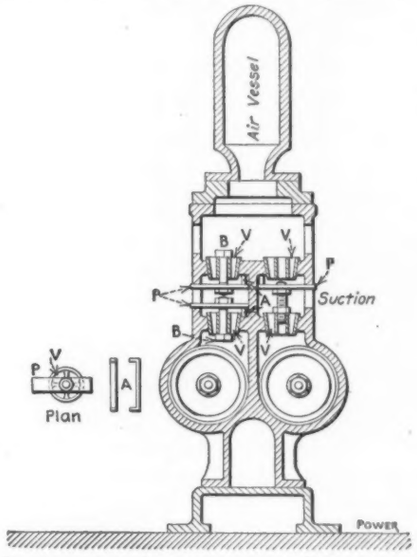
J. R. MORTON.

Detroit, Mich.

Removing Pump Valve Seats

Two months ago I was given the job of taking the bearing on the suction and delivery valves off a feed pump. The bearing surfaces on the valves were so poor that it was necessary to remove the seats and true them up on the lathe.

It was a difficult thing to remove the seats, as will be seen from the accompanying sketch. I used the device shown. I had a horse made like that shown at *A;* placed it on the farther side of the valve box and across it placed a plate *P* with a hole in the center, as shown in



DETAILS AND APPLICATION OF DEVICE FOR REMOVING VALVE SEATS

the plan at the left of the sketch, and through the center of the valve seat *V* and the plate passed a bolt *B* and tightened it on the other side, as shown in the lower part of the left side of the sketch. By this means the seats were easily removed. The method used in fixing the seats is also shown in the sketch. The left top shows the way of fixing the top seats and the right bottom shows the way of fixing the lower ones.

G. B. JOSHI.

Poona City, India.

The high, level cable railway used at the Long Island City, N. Y., power station coal-handling plant runs from the hoisting tower on the dock, through the top of the boiler house, over the coal pocket, at an elevation of 170 ft. above the dock level. It has a capacity for 400 long tons of run-of-mine bituminous coal in five working hours.

Questions Before the House

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues

Transmitting Capacities of Pulleys

I have read with interest Lawrence Whitcomb's letter on "Transmitting Capacities of Pulleys," in the Dec. 5 issue. I do not concede the point that the comparative results of the tests under discussion are novel and contradictory to the experience of other investigators or operators. Quite to the contrary, they confirm previous tests made at Cornell University in so far as comparisons were made on like pulleys. They also conform to the conclusions drawn by at least one extensive mill operator and by another concern which purchases pulleys in large numbers, as to the relative merits of cork inserts. In fact, it was brought out in the discussion of the paper before the National Association of Cotton Manufacturers that in comparative tests made for Mr. Whitcomb, a fiber pulley gave results which point to the same general conclusions, but the results of this particular test were not included in his published report.

In the very nature of the case, it is easy for a casual observer to be deceived in the relative merits of pulleys, since, as was pointed out in the original paper, pulleys having cork inserts have a large carrying capacity, although this is attended with a large amount of slip. A large slip means, of course, low efficiency, but this is not the worst feature because it also means an unsteady speed with variations in load.

With respect to the length of the cork projection above the face of the pulley, it seems absurd to lay any considerable stress upon this point, since in all cases the lengths were reasonable and two lengths of cork projection were tried for each pulley. The first test was with the corks as they came from the factory, and the second with the corks sandpapered down to as near $\frac{1}{64}$-in. as could be judged. Considerable care was taken in each case to get the exact projection, and this was recorded for the information of those desiring to study the effect of different cork lengths. If it were true that slight changes in the cork projection materially affected the transmitting capacity of the pulley, this would be a strong argument against the use of corks.

The initial tension of approximately 170 (actually 168.8) lb. per square inch of cross-section was chosen as a basis for comparison of the different pulleys because it is believed to approximate average practice. In the experiments of F. W. Taylor, reported in the *Transactions* (1894) of the American Society of Mechanical Engineers, the initial tensions in all oak-tanned leather belts was from 192 to 229 lb. per square inch. In view of the fact that Mr. Taylor is one of the strongest advocates of low belt tensions, the contention that 170 lb. is excessive does not seem reasonable.

If Mr. Whitcomb will refer to the complete report covering the entire set of tests, which is in the hands of the secretary of the National Association of Cotton Manufacturers, he will find that a comparison based on 37.5 lb. per square inch initial tension will be even less favorable to cork-insert pulleys than when based on 170 lb. per square inch.

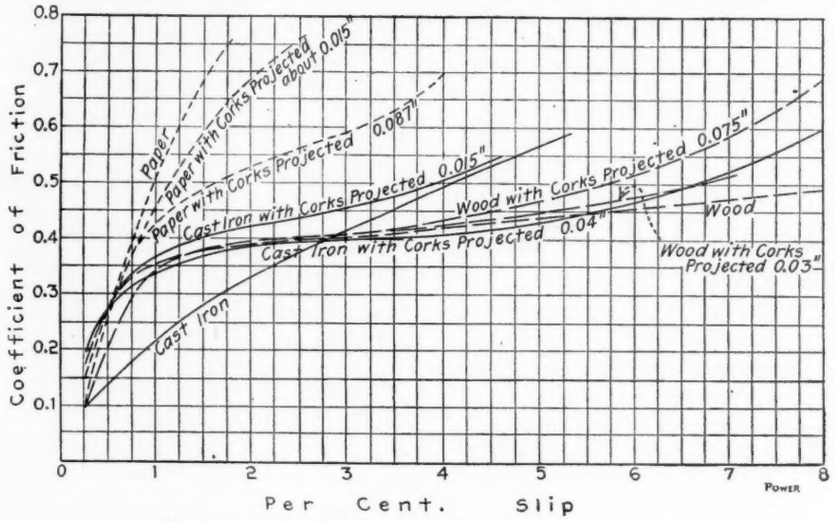
It is to be regretted that the figure used in the abstract of the original paper, which appeared in the Oct. 17 issue of POWER, page 582, is a set of curves for comparing the power transmitted per inch width of belt with the several pulleys, instead of a comparison of the coefficient of friction as denominated.

The figure which should have been used is shown herewith.

It will be noted that these figures are very similar, so that the cuts were easily interchanged. The vertical axis of the figure on page 582 should be "horsepower transmitted per inch of belt width," instead of "coefficient of friction."

The tests were all made under the same conditions, and therefore it does not appear that any injustice could be done any pulley. It is not to be presumed that it is necessary to make tests of all the different pulleys under all the different conditions of installation in order to determine which pulley to use with a given length of belt, given arc of contact, given diameter of pulley and a given speed.

It is not apparent just what "maximum figures" Mr. Whitcomb has in mind in speaking of Table 1. Referring to the figure on page 582 of the Oct. 17 issue, and bearing in mind that the vertical axis is horsepower transmitted per inch of belt width instead of coefficient of friction, it will be seen that at 2 per cent. slip the paper pulleys carried 5½ hp. per inch width of belt, that the paper pulleys with corks projecting 0.015 in. above the surface carried 5½ hp. per inch width at 2.7 per cent. slip, while none of the other pulleys carried this load until the slip had reached 4½ per cent. or more. In view of this fact, it is not clear what "maximum figures" Mr. Whitcomb would like shown.



VARIATION OF COEFFICIENT OF FRICTION WITH SLIP

The criticism of Table 2 seems to be due to a lack of comprehension of its purpose. In order to make a fair comparison, it is necessary to reduce the things being compared to like conditions. It was pointed out by the author that a comparison such as made in Table 1 is not fair in that the stresses in the belt and the arcs of contact are not all the same. This is due to the very fact that the loads carried by the different pulleys at a given

slip are not the same. For example, referring again to page 582, it will be seen from Table 1 that at 2 per cent. slip the paper pulleys were carrying a load of 5.46 hp. per inch of belt width, while the cast-iron pulleys were carrying but 2.16 hp. per inch width. This means that the stress in the belt in the case of the paper pulleys is large in comparison with that for the cast-iron pulleys for this particular slip. For the same reason, the arcs of contact are different.

In Table 2, the results were computed for the several pulleys reduced to identical conditions of belt stress and arc of contact and at the same time using all the other factors as they were obtained from the data of the tests.

The belt stress of 250 lb. per square inch was chosen because it is, in round numbers, the average stress actually obtained with the cast-iron pulleys from minimum to maximum loads. This may have been confounded with initial tension by Mr. Whitcomb. In any event, reference to any of the standard handbooks, as, for instance, Kent's, will show that it is not excessive. Furthermore, an inspection of the formula used (Nagle's) will show that the results in a comparative way would not be affected whatever by the value used for belt stress.

W. M. SAWDON.

Ithaca, N. Y.

Sand for Hot Boxes

I have been following the discussion on "Sand for Hot Boxes" with much interest, and waiting for someone to tell readers of POWER the why of it all.

The term, sand, can be understood to mean any degree of coarseness. No doubt some of the writers have taken up the discussion on the assumption that the coarser grades of sand were meant, which, in my mind, is all wrong. The grade to use, if any is used at all, is the grade that would be given off by a grindstone or finer still if obtainable.

Every engineer knows that sand or any other gritty material will not cool a hot bearing but will make it hotter.

When sand cures a hot bearing it only takes away the cause of the heating, which may be either a poorly aligned bearing or one that is high in spots. Sand or any other fine, gritty substance will grind away the high places and allow the shaft to bear on the total area; the load being distributed evenly, the friction per square inch is reduced and the heat diminishes.

I once had an experience with sand in a troublesome main bearing of a pumping engine. Sand in this case was not intentional. One night the oiler informed me that the bearing was giving him trouble. After an examination, I concluded the bearing was not too hot for the water cure, and so I ordered the hose connected to the discharge pipe of the main pump, and a slight stream run in the bearing. To my surprise the bearing got hotter and hotter. I took the water off and put my hand down through a hole in the cap and on the shaft. I found the shaft to be covered with grit or sand which had been entrained in the water.

The bearing was washed out with oil, and, after all the sand had been removed, the bearing became cool.

This was my first experience with grinding; although unintentional, it was nevertheless an impressive lesson. I recommend the judicious use of fine grit for chronic hot bearings.

H. R. BLESSING.

Philadelphia, Penn.

Believe me, there is some class to Brother Freer, especially when he uses sand to reduce a hot bearing. If he ever used sand for this purpose on my ship I would make him "walk the plank."

What he saw used was brick-dust, not sand. Brick-dust is a clay and will form an enamel over a shaft or pin, while sand will score the pin and brasses.

ROBERT F. PETRASEK.

New York City.

I laughed when I read the recent article by Mr. Sprague about using sand or grindstone dust in bearings.

From experience I find that lard or sperm oil is the best lubricant for a hot box or bearing. If possible, clean the box before using the oil. I prefer the pure lard oil. A little graphite may be used, but not much as it gums, cakes and fills the oil holes and grooves. I remember on two occasions, with one large and one small gas engine, the crankpin would heat when the load was applied. I emptied out the red engine oil we had been using and put in the pure lard oil, and found that I used no more than the other oil, and had no more trouble.

Should the bearings or boxes be scratched or cut, never allow grit to get in, because the grit will embed itself in the softer metal, whether it be the box or shaft, usually the box, and heat the other and wear it out. If the box is not too badly cut, or pinches the pin or shaft, use a fine file and scraper.

GEORGE R. RITTENHOUSE.

Baltimore, Md.

In a case within my experience sand was put into a bearing to cause a hot box rather than to cure one. A generous handful was put in through the handhole in the pillow (top) block some time in the night while the engine was stopped.

I discovered the sand, however, before the engine was started. I took the cap and top shell off and wiped out as much sand as possible. Then, I turned the engine very slowly and put lots of oil on the shaft and kept wiping it off. I then put on the top shell and cap, started the engine slowly, and had a man pour oil into the bearing as fast as he could. I then brought the engine slowly up to speed, all the time keeping the bearing flooded with oil. I ran it this way for about half an hour and then I cut the oil down to about twice the regular feed. Finally, in a couple of hours the oil was reduced to the regular feed, and I had no trouble with the bearing.

I would have used a hose to flush the bearing out if I had had a water connection handy, but I did not.

I cannot see why it is any worse to put very fine sand into a bearing than it is to use lots of the other things that are employed to grind a bearing in, but one must be sure to wash it all out after it has ground off the high places.

SAMUEL H. WINTERBOTTOM.

Woonsocket, R. I.

The administration of sand to a tight bearing may be likened, in some respects, to the administration of drugs to the human being. Either is only likely to produce satisfactory results when the practitioner handling the case is an embodiment of the late Prof. Huxley's definition of science: it is "applied common sense."

Just as all drugs exercise a destructive effect on some state of the animal makeup, so do all abrasives exercise destructive effects, when forcibly applied, to the surfaces of metals in motion. But destructive disintegration of a part is often necessary in order to enhance the value of the remainder. This is particularly the case in the preparation of the different parts which go to compose a mechanism. The operations of chipping, planing, turning, grinding, lapping and polishing are all more or less destructive, but when successively performed by a skilled mechanic, they result in the conversion of a few rough forgings and castings into something which is a triumph of the metal worker's art. But had any of those pieces of metal been put into the hands of a novice, at any one of these different stages, the result would have been crude indeed.

So it is with the application of sand for the purpose of curing a tight bearing—the final result is dependent on the human equation. Sand, in the hands of an "applied-common-sense" engineer, can be made to perform good service in treating a tight bearing. Try the following: Use a grade of sand which common sense will dictate as being suited to the metals in contact, and be careful to run at a slow speed. When the bearing is sufficiently run down, wash away all traces of sand and polish up the journal with "oil and tripoli powder,"

increasing the speed slightly. Then wash away all traces of the "tripoli," dry out, add a little flake graphite to the first dose of lubricant, run steadily for half an hour, then "let her go."

I have tried the foregoing with good results, and have also experienced the trouble caused by the unauthorized admission of grit to a healthy bearing.

Sand in the engine room may be likened in its effects to whiskey in the home. A medicinal dose of the latter added to grandpa's gruel will loosen up the old gentleman's tight bearings and ease his load, while the same dose imbibed by grandson, in whose veins the blood is "racing" with the energy of youth, will give him such a bad attack of "hot box" that the result will be h—l.

ROY REDDIE.

New Market, Tenn.

Took Gases from the Uptake

Mr. Breckenridge, whose letter under the above title appeared in the Dec. 12 issue, is laboring under a delusion if he believes that he can secure greater economy by taking gases from the flue and returning them to the ashpit in order to recover heat that would ordinarily go up the stack. The reason is well known to most men interested in boiler work, but an explanation of the principles of combustion in this case might be profitable to some people.

The active agent in air is oxygen. Air contains a little over 20 per cent. by volume of this gas. When coal is burned, the carbon of the coal combines with the oxygen of the air and makes an equivalent volume of a gas called carbon dioxide, commonly represented by the formula CO_2. This gas will not burn, neither will it support combustion. In fact, if poured on a fire, it will extinguish it just like so much water. The remaining 80 per cent. of the air is a gas called nitrogen, which is similar to CO_2 in that it neither burns nor supports combustion. Now, in practice it is impossible to use up all the oxygen in the air, as if an attempt is made to do so there will be such a large amount of combustible gases go up the stack that the losses of fuel will be enormous. When gases are returned to the furnace the result would be the same as attempting to use all the oxygen at one burning. Large amounts of carbon monoxide would be produced and, in addition, the oxygen content of the gas would soon get so low that the fire would be smothered.

The only way to recover waste heat from the flue gases is to install some form of economizer, of which there are several designs on the market. If it is desired to preheat the air before using in the boiler, the best way would be to install an air heater of some form. In the sketch shown, if the stove pipe be extended through the flue to the air and kept tight inside the flue so that nothing but pure air can get to the fire, then some economy might be effected. However, the economy effected by heating the air might be offset by troubles with clinkers or by the grates burning out; this idea of preheating the air was dropped long ago for these and similar reasons.

The reason why an increase in the evaporation resulted was, in my opinion, because the ashpit was closed up, thus choking off the air supply and thereby getting nearer the right amount of air into the furnace. The steam blower also makes a kind of forced draft. In fact, on examining the sketch carefully, it seems to me that very little gas would be sucked down from the uptake, as the draft is strongest at this point and it would be much easier to suck in air through the annular space around the blower. It would be interesting to know whether the hot gases in the stove pipe were actually coming down from the stack or whether they were coming up from the ashpit. If the chimney was very tall, the draft in the chimney would overcome the suction of the steam blower as arranged in the sketch. To get positive suction from the blower, it should be set tight in the brickwork so that the entire suction would be inside the pipe or furnace.

JAMES E. STEELY.

Covington, Va.

Effect of Air Pressure

I was interested in reading Mr. Moore's story under the above title in the Dec. 5 issue, but on thinking it over it appears that the events were not described quite as they would actually have happened. Mr. Moore states that as the engineer opened the blowoff valve the pump "kicked." I cannot see any relation between the blowoff valve and the pump that would cause it to "kick"; probably what was meant was that when the pump was relieved of the pressure which it had built up in the boiler by the opening of the blowoff, it started up. It should not have kicked on being relieved of its pressure. Then, again, he states that, as usual in this type of boiler, there were two manholes, one in each flue sheet. This is the first that I have heard that this is usual in present-day practice.

As regards our friend who got the water in the neck: If there were 172 lb. pressure on the plate, as Mr. Moore claims, it looks strange to me that it had to be rapped with a wrench to start it, as the new gasket which he had put in certainly did not stick tight enough to hold the cover plate against 172 lb. pressure when it was cold. It would appear to me that with a new gasket the minute he slacked off on the nut, if there was a vacuum in the boiler, air would leak in around the gasket until the pressures were equalized.

It would also appear that Mr. Moore's figures on the difference in pressures on each side of the plate are not quite right as there evidently was water on the inside of the boiler or our friend would not have got wet. The pressure due to its head would have to be taken into account when figuring the pressures on the inside. Taking an area of 99 sq.in. and assuming 2 ft. of water above the manhole would give a pressure against the vacuum inside of

$$99 \times 2 \times 0.43 = 85.14 \text{ } lb.$$

Mr. Moore also forgot to put his blow-off-pipe outlet under water as he does his barometer, for he states that they saw the water trickling out of it. If he did not, I do not see how he could get a vacuum in the boiler because the air would run up the pipe and the water would run down in gulps in much the same way as water would run out of an inverted bottle which is full.

Taking it all into consideration, it appears to me that the way in which the engineer got wet was his use of enough strength to force the manhole cover in against the pressure due to the water behind it and his inability to get away quickly enough. Apparently the air pressure played no part in the matter.

O. J. RICHMOND.

Bridgeport, Conn.

On Quoting Prices

Much has been said recently about the publishing of prices, and I wish to give some of my experiences in that line.

I recently wrote to one of the advertisers in POWER for a description and prices of grease cups manufactured by them. They replied, stating that they would send descriptive matter and that my inquiry was sent to their nearest branch office. The descriptive matter did not show up, but in a few days I received a letter from their branch office, stating that if I would give the size of grease cup I wanted they would be pleased to quote prices.

At another time I wrote a prominent company for a price on a hydraulic wheel press. I had their catalog and selected the one best suited to our needs, and sent in the description given. They replied, stating they were sending a catalog, and, referring me to a certain page, asked me to inform them whether the press described thereon would be satisfactory. This press was the one on which I had asked the quotation.

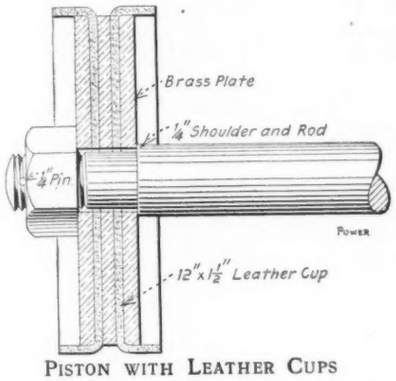
In both of these instances there was unnecessary delay and correspondence, which do not tend to promote sales.

C. E. HENRY.

Bessemer, Mich.

Leather Piston Packing

I noticed in the Nov. 28 issue the plan of packing a pump piston with leather washers, six all told, as shown in the sketch. This idea is one of the oldest known for cold water.



PISTON WITH LEATHER CUPS

The accompanying sketch shows a piston packing which will be used more in pumps if engineers will specify it for cold water.

WILLIAM NOTTBERG.

Kansas City, Mo.

The Wage Question

I have read the editorial on "The Wage Question" in the issue of Nov. 28. I believe that one of the reasons why engineers are not better paid is that, though their hourly rate is lower than in many other callings, the greater number of hours bring the pay envelope up to about what the employer thinks the engineer must have to live on. In other words, with fewer hours the engineer's rate per hour would be greater.

There are fascination and interest about an engineer's work that are absent from bricklaying or barbering, and this makes men with engineering talent prefer the work, even if the pay is not so high. It takes brains and knowledge to be an engineer, but many a man is drawing his 60c. an hour laying brick who cannot square up the lines for a pigpen or write his name. I think unionism has much to do with this and that this class of tradesmen is usually employed by contractors, who pass the cost of high wages on to the owner of the building.

Carpenters in this section get 37½c. per hour on outside work, but in mill work, where they are employed the year around, they can be hired for much less.

Engineers are not alone; the machinists, who must have knowledge and skill, usually receive not more than three-fifths as much wages as the bricklayer. The amount earned per year probably has much to do with the matter and on this point the engineer has the advantage over the building tradesman. A bricklayer friend of mine claims that very few brick masons make $600 a year.

J. O. BURCH.

Woodhaven, N. Y.

The issue of Nov. 28 contains another contribution of the above subject, which is one of which we should never lose sight.

Engineers do not lack education or wage-earning capacity nearly as much as they lack proper organization. With the existing organizations it is impossible to establish a standard wage scale because of the variation in requirements of the different plants and the too frequent willingness of some members of the same organization to "knife" each other just because the other fellow's job looks good. The ever prevailing jealousy among engineers must be got rid of and we must pull together rather than "scrap" all the time.

THOMAS M. STERLING.

Middlebranch, Ohio.

I am interested in the discussion in POWER, as to engineers' wages, and I think some good suggestions have been offered for their betterment. Some have contrasted engineering with other trades and callings, that are more successful as to wages, and hours of duty. They are so because they are better organized. Where would many of the professions be if they did not prohibit those of moderate education, influence, etc., from entering their ranks?

The engineers should unite in having laws enacted prohibiting inexperienced and incompetent persons from taking charge of power plants where lives and property are jeopardized. Then there would be more remuneration for the capable, and more incentive to forge ahead and attain some of the honors that are higher up. I read Prof. Adams' letter in the Dec. 12 number with some chagrin. He says: "When a man at home gets a 'grouch' and thinks the boss is not treating him right, just let him think of the workmen out here and forget the 'grouch.'"

I, for one, am not inclined to take his advice and I hope it will be many years before other operating engineers do. I hope the engineers will redouble their energies to improve their condition.

CHARLES MARS.

Richmond, Va.

I have been greatly interested in the numerous contributions on this topic, but I do not agree with much of what has been written so far. I have been striving to devise some remedy and I now believe I have one.

Let the young engineers who think there is more in it for them as masons, carpenters or plumbers drop their engineering work and learn one of these better-paying trades. Also, let those first-class engineers who know more about plumbing than the plumbers themselves switch right over into that trade and thereby get better wages.

This procedure will leave us who are not kicking a larger field to work in.

L. JOHNSON.

Exeter, N. H.

Engineers' Wages in China

Prof. Adams' letter in the issue of Dec. 12 gives us Americans a glimpse of oriental efficiency which is quite interesting. By way of comparison, I would like to present the wage cost per kilowatt of a New England plant with which I was associated; it was a small plant, but somewhat more difficult to handle than Mr. Adams' plant, though it was practically in the same class.

The equipment consisted of two boilers, a 125-hp. engine, supplying motive power to the shops, a 20-kw. generator and an arc-light machine. One engineer devoted his whole time to the plant, and a machinist gave about half of his time, never any more, and most of the time much less. The duties of these two men consisted of taking full care of all power-plant work, with no other assistance.

The engine and dynamo room was always in excellent order. The work included firing, cleaning and taking care of the boilers, pumps, engine, generators and motors about the plant; and care of two 50-ton electric cranes as well as the installation and care of all lighting and repairs to the steam plant. Thus, it is evident that the auxiliary work besides power generation was fully as great in this plant as in that mentioned by Prof. Adams.

The maximum pay for these men was $15 per week each, but at the time of which I write, neither was getting this pay. The power-plant cost was $22.50 per week, or $1170 per year, of 52 weeks, for the distribution of 90 kw. or $13 per kilowatt per year. Mr. Adams' wage at $43.80 per month is $525.60 per year, or $17 per kilowatt per year. In addition, he must supply means for five men to work in the way of tools, etc., and consider that the cost is raised in distributing work among five men over that necessary for such a factor between two men. Again, a certain portion of his own salary must be charged to power production, which was not the case in the plant mentioned, as the superintendent left the work entirely in the hands of the engineer.

These figures speak for themselves as to the value of intelligence. The engineer came to the shop about 5:30 a.m. and left about 6:15; on Sunday he spent an average of about five hours at the plant, while during the day on many occasions he had no actual work to do, being required simply to be in or about the engine room. The machinist worked 60 hours per week.

JAMES A. PRATT.

Williamson School, Penn.

A Pumping Problem

In regard to the centrifugal-pump problem presented by R. B. Crockett in the Dec. 19 issue, I would say that if there were no increase in friction head or eddies created in the pump, the volume pumped for the same number of revolutions would vary inversely as the square of the head; it is rather near that figure as it is.

Suppose there is an 8-ft. head and the pump is handling 10,000 gal. per minute. If the head were cut to 4 ft., the pump would handle 40,000 gal. per minute, or the equivalent of 20,000 gal. against an 8-ft. head. Hence the pump would do twice as much work as before, so if the engine is running with a fixed cutoff, is would slow down until it could do the work that the cutoff will allow.

EDWARD H. LANE.

Kansas City, Mo.

The greater the volume of water a centrifugal pump moves, the more power it takes. If the pump has to lift the water or pump it against a pressure, there is a certain amount of slippage of the impeller, and this slippage increases with the increase of the height of lift or the pressure.

A centrifugal pump requires less power to run it with the discharge pipe closed and the impeller churning the water than it does to pump through a free opening.

In Mr. Crockett's case, the rising of the river shortens the distance between the suction and the discharge, the slippage is less and the pumps move a larger volume of water and consequently require more power to run them.

L. M. JOHNSON.

Glenfield, Penn.

Many impellers, generally of old design, will overload the power end of the unit when the static head is reduced, because the capacity increases with consequent increase of velocity of water through the impeller and passages, and the friction caused by this increased velocity of water plus the increased velocity head, combined with the greater capacity, produces as great or greater a load than normal conditions of capacity with somewhat higher static head will produce. The governor being disconnected causes the engine to slow down as it is getting no more steam than before. There are also losses in the pump passages, due to high water velocity, which take power from the engine but which are not credited to the pump.

Impellers are being designed now which will not overload with a reduced static head. This condition is a necessity in the centrifugal fire pumps where a break in the pressure main might overload and seriously damage the driving motor.

W. C. DOWD.

Camden, N. J.

When the river rises, the head consequently becomes less, and more water is taken into the pump in a given time. With the lesser head, the product of the weight of water taken into the pump and the head is greater than the product of the weight of water taken into the pump and the head for the river at a medium stage. In other words, more work is done when the head is small because a greater quantity of water is handled by the pump. It is true that the water is lifted through a smaller distance, but the increase in quantity is more than enough to offset the difference in the head. As the runner of the pump is required to handle a greater volume of water, the engine driving the pump is required to do more work, and, since the governor of the engine is disconnected and the cutoff is fixed, the engine slows down under the increased load.

In order to make this clear, take the case of a centrifugal pump in which the head is so great that no water is being discharged. The runner of the pump will then merely churn the water in the pump and very little power will be required to run it. Now, suppose that the head is gradually decreased. The quantity of water discharged will be gradually increased, but the quantity of water handled by the pump will increase faster than the head will decrease, so that the work done by the pump will gradually increase. This may not be true for all speeds, as the speed of the runner to get best results should be changed to suit the head. Theoretically, the speed of the periphery of the runner should be the same as the speed attained by a body falling through a distance equal to that of the head.

T. W. HOLLOWAY.

Scranton, Penn.

When the head drops, the weight of water pumped per minute increases so that the load is increased. Thus, if the 48-in. pumps are throwing 100 cu.ft. per second at normal speed and 8½ ft. head, the engines would be delivering about 97 hp. If the head fell to 7½ ft., the pump would throw about 120 cu.ft. per second, if the pump remained at constant speed. This would require about 102 hp. With a constant cutoff, the engine will, of course, slow down until the weight of water pumped drops off so that the engine can carry the load. Further, the efficiency of the pump may be less at 7½ ft. head, and this would further increase the load on the engine.

I would hate to be around that plant if the suction or delivery pipe were to get stopped up and there were no safety cutoff on the engines. It makes me nervous to see an engine running with the governor disconnected.

GEORGE L. SULLIVAN.

Bozeman, Mont.

The reason why Mr. Crockett's pumps slow down when the river rises is because the load increases when the head decreases on a centrifugal pump. For a given speed there is a head against which a centrifugal pump will discharge no water. Thus, if a pipe is extended above this point no water will be pumped and no power will be used except that required to turn the runner in the pump.

If the discharge pipe be cut off, say, 1 ft. below the point where the pump maintains the water, considerable water will be discharged and the load will jump up in proportion to the amount pumped. If the pipe be shortened still more, the amount of water will increase rapidly and the load will get so heavy that in some cases it will stall the driving unit.

Centrifugal pumps are subject to much abuse. For a given head, there is an economical capacity, and if this be exceeded greatly, usually the efficiency falls off rapidly. It is easy to get an increase in capacity by speeding up the pump slightly, but in many cases this is a continual expense, due to decreased efficiency, which would more than buy an extra unit. Before making any changes in the speed, if it is not possible to make a test one's self, it is better to get advice from the builders as to the economy of the pump at the new speed.

JAMES E. STEELY.

Covington, Va.

[Other explanations similar to the foregoing were received from Myron D. Place, F. P. Read, Phil Lighte, A. Coffee, J. K. Blake and M. R. Frost.—EDITOR.]

What Means the Dome?

The logging engine referred to in the Dec. 26 issue interested me as I formerly was in the timber business myself, and perhaps can throw some light on the dome.

Some years ago, before sawmill men learned to do things as systematically as they do now, the men who laid the logging roads did not take the time to grade the hills, make fills and trim the track as at present. It looks to me as if the engine under discussion was designed for use in a hilly country and the dome was put on to insure steam without too much water mixed with it in going up or down hills. It was often necessary to carry the boiler full or nearly full of water to prevent the ends of the tubes and the top of the crown sheet from getting bare and burning when climbing or descending hills.

The engine may have been moved from some Northern woods to its present location after the fields for which it was built were cleaned off.

A. A. BLANCHARD.

Ocala, Fla.

Inquiries of General Interest

Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it

Purchasing Coal on B.t.u. Basis

How is coal purchased on the B.t.u. basis, and how are the B.t.u. computed?

C. W. B.

British thermal units may be determined by using Dulong's formula, by burning coal in the presence of oxygen in a bomb calorimeter or by mixing coal with a chemical compound whose oxygen content is readily liberated and burning in a suitable receptable. In the latter two methods the B.t.u. are determined by the rise in temperature of a predetermined quantity of water surrounding the bomb or receptacle in which the coal is burned. Contracts are usually based on a specific number of B.t.u. per pound of coal. If, on analysis, the sample falls below the specified amount, the coal dealer is penalized; if above, the coal dealer receives a bonus. The percentage of moisture, ash and sulphur, in conjunction with the B.t.u., as a rule, determines the cost.

The following rule is based on the total heat of combustion of any compound of carbon, hydrogen and oxygen:

Divide the percentage of oxygen in the coal by 8 *and subtract the quotient from the percentage of hydrogen, multiply the difference by* 4.28 *and add to the product the percentage of carbon; then multiply by* 145, *and the product will be the number of B.t.u. in a pound of fuel.*

While burning a sample with oxygen under pressure in a bomb calorimeter is the standard method, a fairly accurate one is as follows:

Place 1 gram of finely powdered coal with 60 grams of litharge (lead oxide, PbO) and 10 grams of ground glass in a clay crucible; cover with a layer of salt. Next cover the crucible and heat to redness for 20 min. Then cool and break crucible and clean and weigh lead button. The number of grams of lead obtained from 1 gram of coal multiplied by 483 gives the B.t.u. in 1 lb. of coal. This is a modification of Berthier's method as described by Prof. A. H. Gill in his work on flue and gas analysis. An article on coal purchased on the B.t.u. basis will appear in an early issue.

Size of Piston Rods

What is the rule for finding the size of steam-engine piston rods?

J. L. B.

The average practice is the product of the square root of the product of diameter of the cylinder and the length of stroke in inches and 0.145 for high-speed engines or 0.11 for low-speed engines.

Assume an engine 20x48 in., substituting figures for the rule it would be expressed thus,

$$\sqrt{20 \times 48} = \sqrt{960} = 30.98$$

diameter of rod equals

$$30.98 \times 0.11 = 3.4 \text{ in.}$$

Bumped and Concave Heads

What is the rule for the pressure allowed on bumped and concave heads?

L. C.

For bumped heads multiply the thickness of the plate by ⅛ of the tensile strength and divide by 0.6 of the radius to which the head is bumped. The pressure allowed for concave heads is 0.6 the pressure allowed for convex (bumped) heads.

Load Factor and Power Factor

What is the difference between load factor and power factor?

H. A.

The load factor of an electric plant is the ratio of the average to the maximum output. The ratio of the real watts to the apparent watts is the power factor. The power factor is that quantity by which the apparent watts expended in the system must be multiplied in order to give the true watts; it is numerically equal to the cosine of the angle the amperes lag behind the voltage.

Suppose it is desired to transmit 100 kw. over a line, and the current lags behind the voltage by an angle of 25 deg. The cosine is then equal to 0.90, and the power factor will be 0.90. The true watts will equal the apparent watts × 0.90 or volts × amperes × 0.90. If the voltage used in transmission is 1000, 100,000 ÷ 1000 × 0.90 = 111.1 amperes. If the power factor had been unity, only 100 amperes would have been required.

Power for Chain Block

If a chain block is operated by a motor having a speed of 2500 r.p.m., what power would be required to lift 1000 lb? If it took 1 hp. to raise this weight 30 ft. and the weight was suddenly released, what power would it develop in descending?

J. F. M. I.

To lift 1000 lb. at the rate of 30 ft. a minute would take

$$30 \times 1000 = 30{,}000 \text{ ft.-lb. per min.}$$

A horsepower is 33,000 ft.-lb. per min.; therefore it would take

$$\frac{33{,}000}{30{,}000} = \frac{10}{11} \text{ hp.}$$

applied to the weight. The power applied to the shaft of a hoist would depend upon the efficiency of that mechanism. If the efficiency, for instance, were 80 per cent., the power required would be

$$\frac{\frac{10}{11}}{0.80} = 1.136 \text{ hp.}$$

The weight in descending would develop

$$30 \times 1000 = 30{,}000 \text{ ft.-lb.}$$

of energy. The amount of power developed would depend upon the velocity of its descent. If it took it a minute to fall, the average horsepower developed by the weight would be

$$\frac{30{,}000}{33{,}000} = \frac{10}{11} \text{ hp.}$$

If in a second,

$$\frac{30{,}000}{550} = 54.5 \text{ hp.}$$

The time required by a body to fall freely through a given height is, square root of the height ÷ 4.01. The square root of 30 = 5.48, and 5.48 ÷ 4.01 = 1.37 sec. The average power developed upon itself in falling freely will be

$$\frac{30{,}000}{1.37 \times 550} = 39.8 \text{ hp.}$$

This increase of horsepower does not represent a gain; it is simply a more rapid use of the available 30,000 ft.-lb. of energy, which cannot be increased by any mechanical device, nor in any other way than by the conversion of other energy.

Galvanized Iron Ammonia Pipes

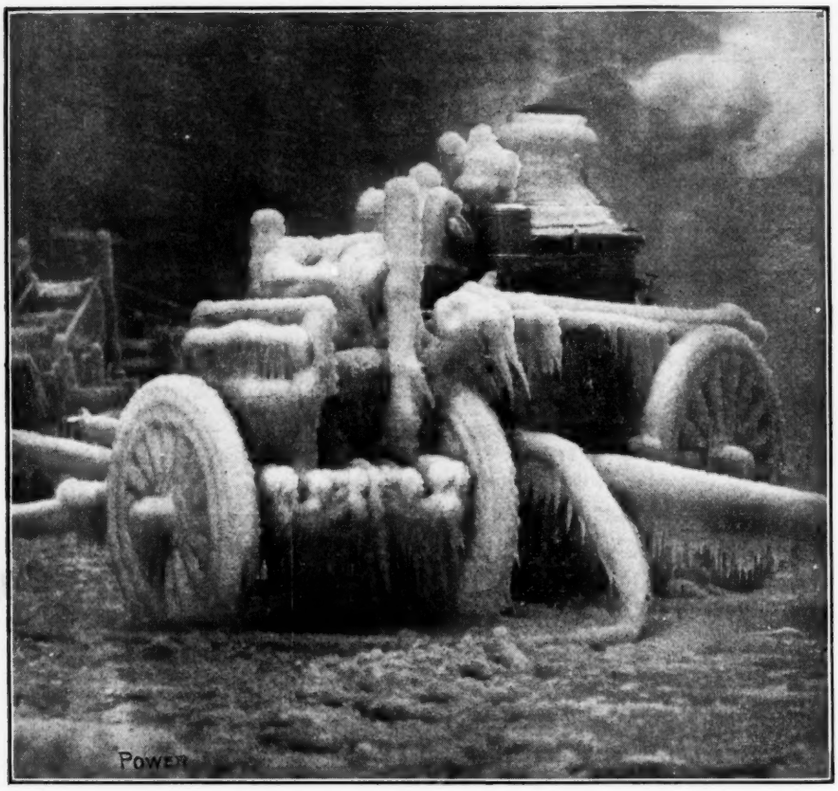
What is the objection to using galvanized pipes in double-pipe ammonia condensers?

W. J. C.

The only objection is that the ammonia is disintegrated by the material used in galvanizing the pipe and some scale and noncondensible gases are formed. For this reason galvanized pipe is used only when the condensing water is so bad that there is a distinct advantage in its use. The inner pipes of double-pipe condensers are for this reason quite frequently galvanized.

Equitable Life's Fire

Severe criticism has been directed against Arthur C. Davis, chief engineer of the Equitable Life Assurance Society's home-office building at 120 Broadway, New York City, for having attempted, with his men and apparatus, to quench the fire which later destroyed that building on the morning of Jan. 8, instead of sending in an alarm when the fire was first discovered.



PUMPING WATER UNDER DIFFICULTIES

Mr. Davis declared the next day that he did not know who turned in the alarm; that his first thought was for the seven 125-hp. boilers in the basement carrying a pressure of 85 lb., and that if the fires were not drawn there would be an explosion which would cause great loss of life.

He also explained that he worked "from 5:30 a.m. until noon drawing the fires from the seven boilers," and "then only escaped by prying open a frozen door with a crowbar." How the chief engineer of a big plant like the Equitable, the successor of James Wilson, happened to be in the building at that early hour unless he had an intimation of trouble is yet to be explained.

Much credit is given by the daily press to the engineers of the adjacent office buildings for their valuable assistance to the fire department. It was necessary, owing to the lack of pressure and the sixty-mile gale that scattered the streams of water, to couple 15 or 20 lines of hose to the standpipes of these buildings, and even to utilize the standpipes on the fifth and sixth floors.

Several of the office-plant engineers remained on watch over 28 hours for the purpose of keeping the fire pumps running. Chief Engineer Trolsen, of the Hanover Bank Building, was on duty throughout the fire directing his force and the working of the pumps pressed into service by the fire department.

The accompanying illustration is typical of the appearance of the fire engines and the conditions under which the fire department's engineers had to labor. It is hard to believe that this ice-encased engine is pumping its quota of water while ice-locked to a street which is ordinarily one of the busiest and most crowded thoroughfares in the world.

This conflagration illustrates the general neglect on the part of employees to promptly obey the injunction of every fire department: "Send in an alarm first!" If this had been done, this fire might have ended in a petty blaze instead of becoming a conflagration which caused a shocking loss of life and property.

The lesson is plain that wherever oil and waste, exposed heaps of rubbish or other combustible material are allowed to collect, the fire hazard is enormously increased. And cleanliness and care are as necessary to safeguarding life and property in a power plant as elsewhere.

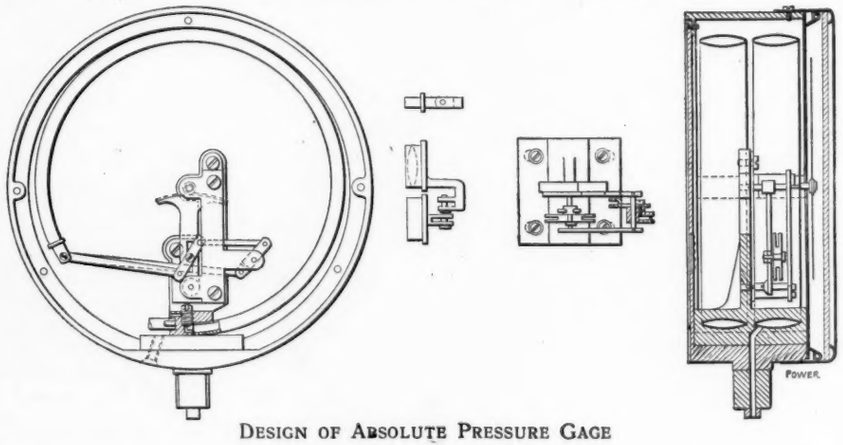
Absolute Pressure Gage

In large plants where the units are operated condensing, it is of great importance to be able to ascertain with accuracy the absolute pressure in the condenser, as with a big unit even a fraction of an inch of mercury difference in the vacuum means a large gain or loss in the steam required to develop a given output.

The ordinary vacuum gage is influenced by the changes in atmospheric pressure as well as the changes in vacuum in the condenser. In other words, it is merely a differential gage, showing the difference in pressure that exists between the inside and the outside of the condenser.

The gage herewith illustrated indicates the absolute pressure that exists within the condenser irrespective of the atmospheric pressure without. It is described in the London *Engineer* as follows:

The gage consists essentially of two Bourdon tubes coupled in such a manner as to oppose each other in their action. The inside of one tube communicates with the inside of the condenser while the outside is open to the atmosphere. This tube therefore is actuated by the difference between the atmospheric pressure and the absolute pressure in the condenser. The other tube is evacuated and sealed and therefore is actuated only by the changes of atmospheric pressure.



DESIGN OF ABSOLUTE PRESSURE GAGE

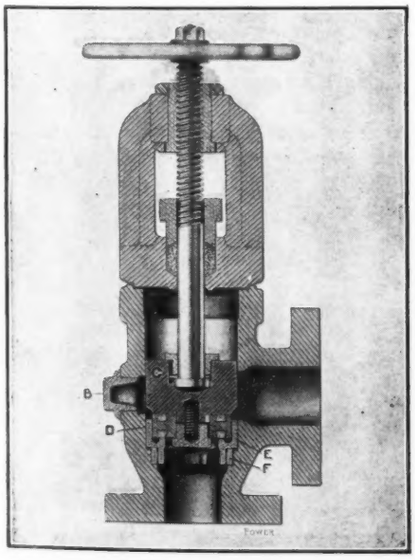
Thus, if the absolute pressure in the condenser increases from, say, 2 to 4 in. while the atmospheric pressure remains the same, the finger of the dial will be advanced accordingly and 4 in. absolute pressure will be indicated. If, on the other hand, the absolute pressure in the condenser increases from, say, 2 to 4 in. while the atmospheric pressure falls 1 in., the increase of pressure inside the tube would be 2 in. and the pressure outside the tube would decrease 1 in., and the resultant motion imparted to the pointer of the ordinary gage would indicate a change of 3 in.

In the absolute pressure gage, here described, the atmospheric pressure acts also on the outside of the evacuated tube and the fall in pressure will permit this tube to expand and thus oppose the action of the other tube to the extent of 1 in., the resultant motion transmitted to the pointer will be equal to 2 in. and an indication of 4 in. absolute pressure will be indicated by the pointer.

In the accompanying figure it will be seen that the two tubes are not coupled direct to the quadrant; their motion is transmitted by a compensating link motion which removes the difficulty of the operating tube having to overcome the effect of the elasticity of the other tube and avoids at the same time the friction which would be produced by the two tubes acting on one pinion in opposite directions.

An Improved Blowoff Valve

A great fault with some types of blowoff valve is that the seat is so located



THE "DURO" BLOWOFF VALVE

that as the disk approaches it the conditions are favorable for the accumulation of scale and sediment. Often the effect of such accumulation is to cut the bearing surfaces to such an extent as to cause the valve to leak. The valve herewith illustrated is the "Duro" blowoff valve, manufactured by the Lunkenheimer Co., of Cincinnati, Ohio; it is designed to overcome the difficulty just specified.

The plug *C* carries the reversible double-faced disk *D*. The bronze seat ring *E* is screwed into a second ring *F*, which is of brass. The object of this is to make the renewal of ring *E* easy in case it becomes worn. There is a plug *B*, at the back, which may be taken out whenever it is desired to clean the valve.

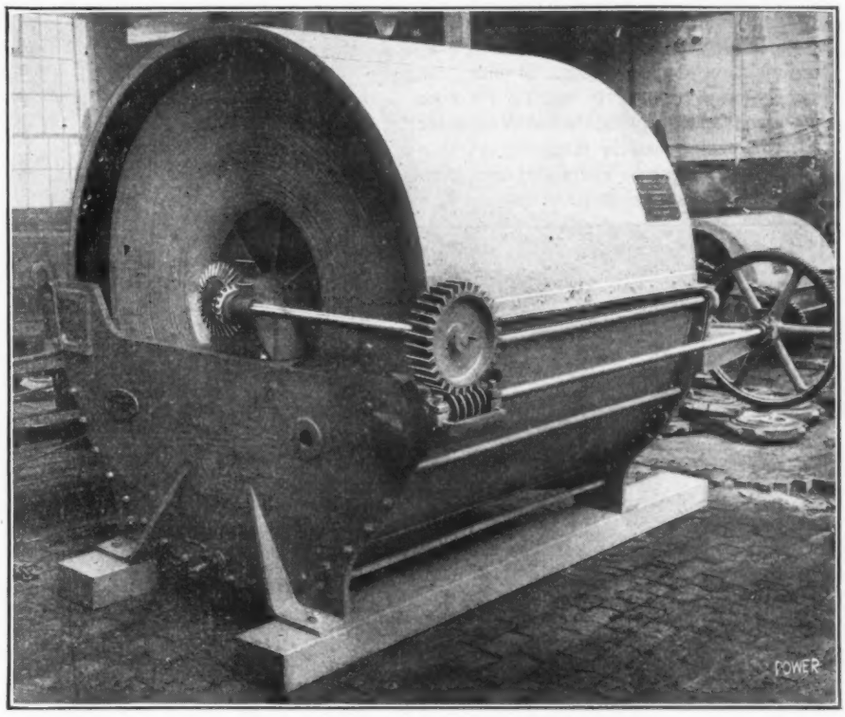


FIG. 1. ROTOR END OF THE WATER COOLER

Power Water Cooler

This machine has been designed for the purpose of cooling the circulating water for internal-combustion engines, air compressors, ammonia condensers, etc. The machine consists of a horizontal

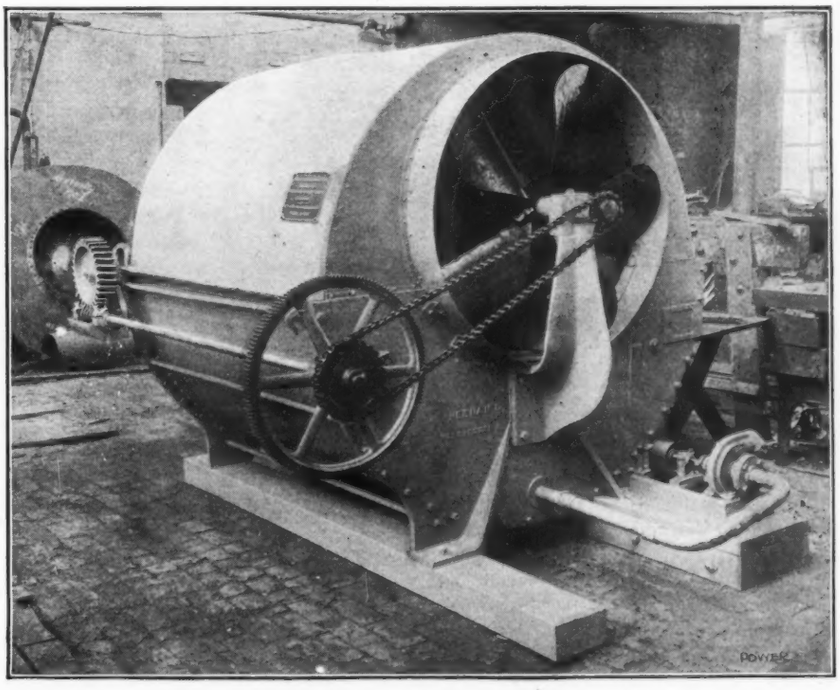


FIG. 2. FAN END OF THE WATER COOLER

casing, through which air is passed, a rotor within the chamber which forms a revolving cooling surface, a fan for circulating the air and a pump for circulating the water to be cooled.

The casing is made of sheet iron, case iron or concrete, according to size, the lower part of the casing forming a trough in which the water circulates. The rotor fills the casing and is made up of thin annular plates which are supported from a central shaft, as shown in Fig. 1. The fan is mounted at the end of the casing and blows air between the plates.

Air and water are passed through the machine in opposite directions, thus forming countercurrents. As the plates of the rotor slowly revolve they pass through the water in the trough and through the air in the upper portion of the chamber.

This brings the wet surface of the rotor into contact with the current of air at each revolution. The thin film of water on their surfaces is partially evaporated by the air which causes the heat given off by the water to be rendered latent; heat is also extracted from the water by a conductor.

The cooler operates noiselessly and, being compact, occupies but little space. It can be set on the floor or placed on brackets on the wall, as shown in Fig. 3.

This machine is manufactured by the Power Specialty Company, 111 Broadway, New York City.

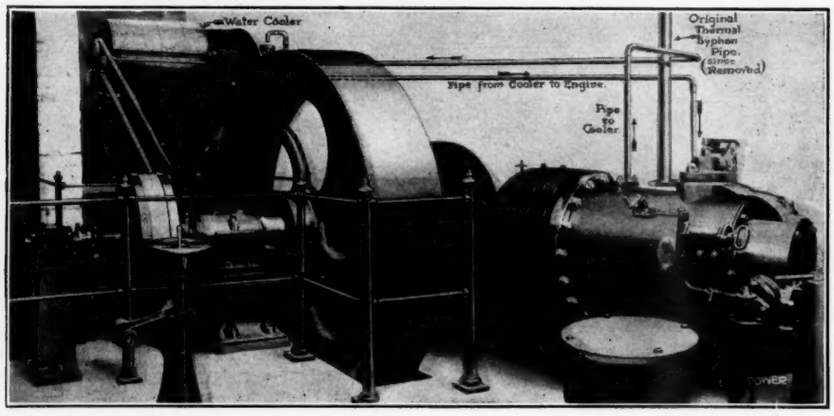
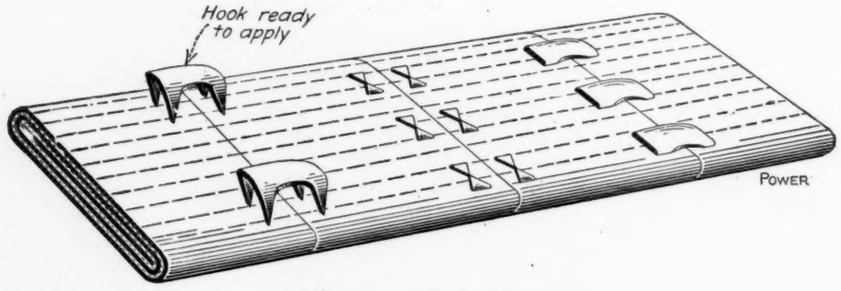


FIG. 3. WATER COOLER AND PIPE CONNECTION TO A GAS ENGINE

"Climax" Belt Hook

One would scarcely suspect that the design of such an apparently simple thing as a belt fastener or hook would be the subject of any very great study. But that such is actually the case is indicated by the number and variety of these devices on the market. One of the newest is the "Climax" belt hook, illustrated herewith.

The "Climax" hook is so made that it enters the belt parallel to the warp, or longitudinal strands, and hence does not cut any of them. An advantage of this form of hook is that while the grip of the hook is in no way impaired, practically the full strength of the fabric of the belt itself is retained. With the "Climax" hook either side of the belt may be run to the pulley with satisfaction. Thus the use of idlers is permitted with belts that are joined with these hooks.



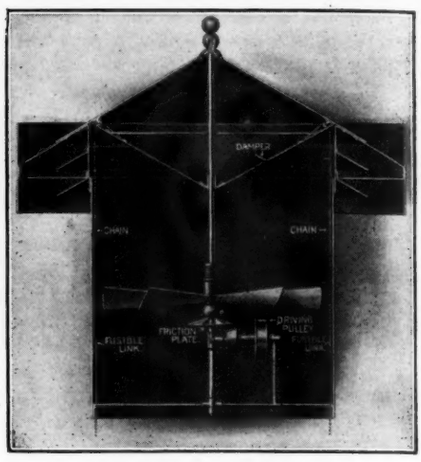
"CLIMAX" BELT HOOKS

The "Climax" belt hooks are manufactured by the Hudson Belt Fastener Company, 136 Liberty street, New York City.

Induced Draft Ventilator

For all ordinary ventilating purposes, the standard natural-draft type of ventilator is entirely sufficient; for some special purposes it is not, as, for instance, that of ventilating a blacksmith shop, a laundry or any other structure in which excessive gases, vapors, fumes, etc., are liberated.

The Burt Manufacturing Company, 232 Main street, Cleveland, Ohio, has just devised and put on the market an addition to its already large family of ventilators in the form of an induced-draft ventilator which is designed for such special purposes as those just mentioned. This new type of ventilator is made in two sizes, 36-inch and 48-inch. The fan, which makes from 250 to 300 revolutions per minute, may be driven by a belt or a direct-connected motor; the power required for each size is about ¼ horsepower. If desired, the fan may be reversed so as to force fresh air into the building instead of drawing off the foul air from within.



THE BURT FAN INDICATOR

The chains by means of which the damper in the top of the ventilator is adjusted have fusible links which will melt out in case of fire and allow the damper to close of its own weight and automatically cut off the draft.

It is said that this type of ventilator will remove about ten times more air within a given length of time than the ordinary stationary type.

New Vulcan Corliss Valve Gear

When the Vulcan Iron Works began the manufacture of mine-hoisting apparatus in 1849, a small steam engine was sufficient to provide all of the power that was necessary to operate the works. Later, as the business increased and various kinds of colliery apparatus was manufactured, a larger power plant was installed which included two 14x18-in. side-crank automatic engines, both of which ran at a speed of 200 r.p.m. and were each belt connected to an Edison bipolar, 220-volt, direct-current generator.

The latest additions to the power plant is shown in Fig. 1. These are two 200-kw. engines, each direct coupled to a Westinghouse 250-volt, direct-current generator and run at a speed of 120 revolutions per minute.

The engines are installed in a brick addition to the old power plant. The engine room is exceedingly light, owing to the large windows on three sides of the building. The floor is of hard-wood

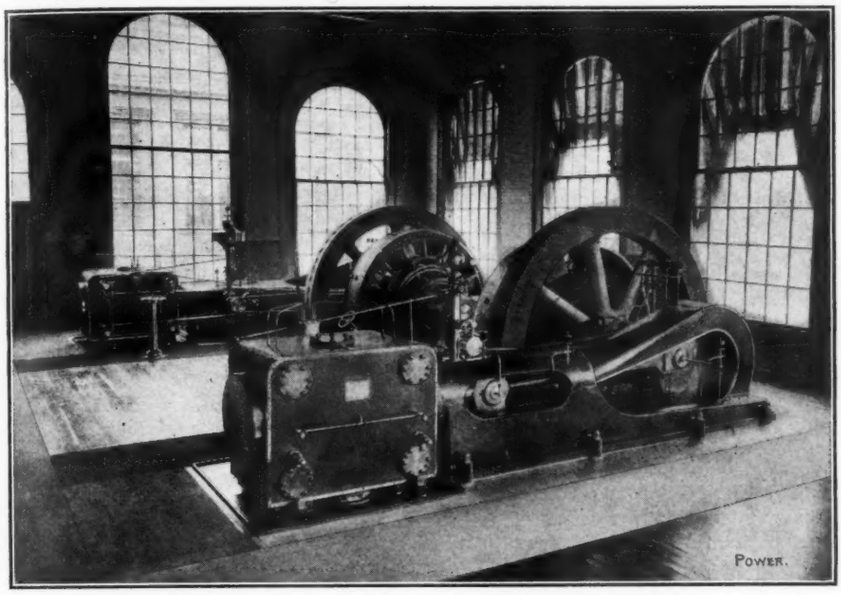


FIG. 1. NEW ENGINE ROOM OF THE VULCAN IRON WORKS, WILKES BARRE, PENN.

finish, with rubber floor matting around each engine.

The most interesting feature about these engines is the new valve-gear with which the right-hand engine, shown in Fig. 1, is equipped. This valve-gear is built by the Vulcan Iron Works, as are both of the engines.

The main object in designing this valve-gear was to reduce the parts to a minimum, to obtain noiseless operation, to bring the pull on the valve stem as close to the engine cylinder as is practicable, and to obtain a valve-gear suitable for high-speed Corliss engines. The valve stem is fitted with an arm which supports a steel latchplate. The dashpot rod is connected to the latchplate arm and the valve is closed as soon as the latch blocks are released.

On the knock-off collar there is mounted a safety cam. There is no knock-off cam as the knock-off collar is made with a suitable knock-off projection, which has easy lines and is so arranged that the cutoff occurs the same as if a knock-off cam were employed.

The other member of the gear swings on the valve-stem bonnet and is actuated by a carrier arm, which connects with a rocker-arm that is operated by the steam eccentric. A stud is fitted in at the bottom of the actuating arm and supports a Y-member, to which is secured a steel catch-block. A thumb-screw passes through the straight arm of the Y-member and screws into a stud that is fitted into the actuating arm. The amount of tension on the knock-off arm against the knock-off collar is regulated by a spring, as shown in Fig. 2.

The Y-member, at the "pick-up" position, tends to fall by gravity into engagement, this tendency being assisted by centrifugal force. The spring is used to overcome the inertia of the latch and cushion its return at disengagement.

The Y-member is fitted with a strip of leather which bears on the knock-off collar. This feature, together with the slight spring tension, renders the valve-gear practically noiseless, and its design makes it capable of running at speeds up to 300 revolutions per minute.

In Fig. 3 is shown the valve-gear hooked in ready to open the valve; Fig. 4 shows the valve unhooked and the reach rod about to travel toward the left.

The design of the gear is such that the force exerted in opening the valve is practically in a straight line with the reach rod. The valve is pushed open by the reach rod moving the Y-member toward the center of the cylinder, and as soon as it is disengaged the valve is closed by the dashpot.

This power plant is in charge of Chief Engineer Edward D. Whitebread, who takes much pride in his work, and the condition of the plant shows that he is fully capable of filling the position he holds.

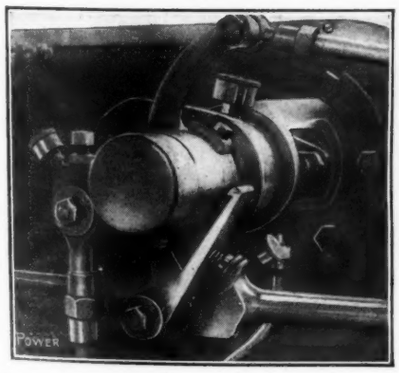


FIG. 2. SHOWING KNOCKOFF COLLAR AND CAM

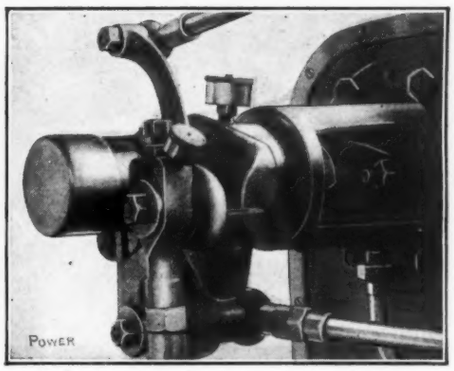


FIG. 3. VALVE GEAR ENGAGED READY TO OPEN VALVE

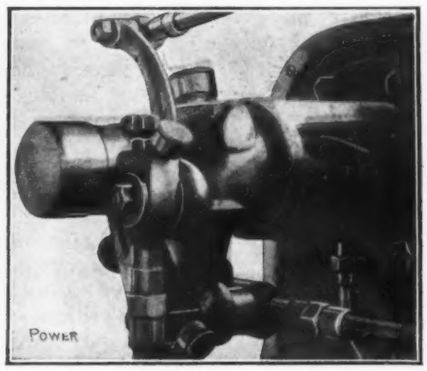


FIG. 4. VALVE GEAR DISENGAGED AND VALVE CLOSED

Bureau of Mines' New Publications

The Bureau of Mines has copies of the following publications for free distribution, one copy to each person.

Bulletin 6, "Coals Available for the Manufacture of Illuminating Gas," by A. H. White and Perry Barker. No. 16, "The Uses of Peat for Fuel and Other Purposes," by Charles A. Davis. No. 19, "Physical and Chemical Properties of the Petroleums of the San Joaquin Valley, Calif.," by I. C. Allen and W. A. Jacobs; with a chapter on analyses of natural gas from the southern California oil fields, by G. A. Burrell.

Reprints—Bulletin 21, "The Significance of Drafts in Steam-boiler Practice," by W. T. Ray and Henry Kreisinger. Reprint of Bulletin 367. No. 26, "Notes on Explosive Mine Gases and Dusts," by R. T. Chamberlin. Reprint of Bulletin 383. No. 29, "The Effect of Oxygen in Coal," by David White. Reprint of Bulletin 382. No. 30, "Briquetting Tests at the Fuel-testing Plant, Norfolk, Va., 1907-8," by C. L. Wright.

Locomotive Explosion at Los Angeles

A locomotive-boiler explosion in the roundhouse of the Southern Pacific R.R. on Lamar St., Los Angeles, Calif., on the night of Jan. 5, caused the death of two men and the injury of three others.

The engine had been employed in local freight service and at the time of the explosion was occupying the first stall at the extreme end of the 48-stall roundhouse. The explosion was caused by low water, followed by the collapse of the crown sheet to such an extent, it is stated, that it dropped into the firebox. The report of the local fire department that the boiler was being filled with cold water at the time of the disaster is denied.

The boiler disengaged itself from the locomotive proper, leaving the engine trucks, wheels and tender standing demolished over the repair pit of the roundhouse. The boiler was blown through the roof of the building and landed at a point in the shop yards about 100 ft. distant. Another engine in the roundhouse was partially damaged through the force of the explosion, and burning timbers from the roundhouse roof caused a slight fire in an adjoining shop building.

The board of inquiry appointed to investigate the cause of the accident has reported as follows: "We are of the unanimous opinion that the cause of the explosion was due to lack of sufficient water on the crown sheet, and that the lack of water on the crown sheet was entirely in the hands of Engine Watchman W. A. Weaver, who was solely responsible and lost his life in the explosion."

Boiler Explosion at Colliery

A boiler explosion on Jan. 13, at Pittston, Penn., in the Clarence colliery of the Hillside Coal & Iron Co. is reported in the daily press. It appears that the wrecked boiler was one of a battery of five and, although there was considerable property damage, the explosion did not result in loss of life or even injury to the employees.

Westinghouse Company Elects Chairman

Guy E. Tripp, of Boston, formerly chairman of the reorganization committee of the Metropolitan St. Ry. Co., was elected chairman of the Westinghouse Electric & Manufacturing Co. on Jan. 10. The office has been vacant since the death of Robert Mather, and the directors considered a large list of men of experience in electrical and railway matters before coming to a decision.

Mr. Tripp, in order to conduct the operations of the Westinghouse company, with its numerous branches in England, France, Germany, Canada and Russia, withdrew recently from the firm of Stone & Webster. He has been connected with local traction matters for a number of years.

Power Merger

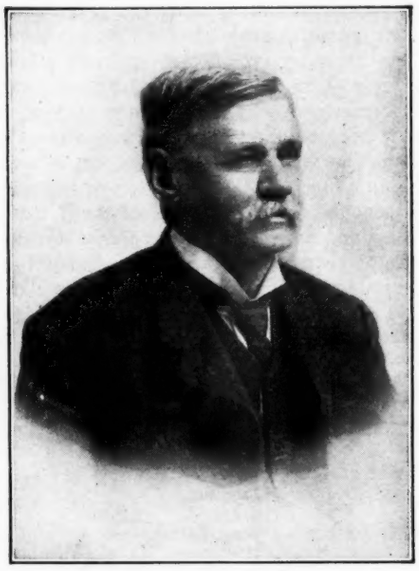
There was formally presented to the Public Service Commission, Second District, on Jan. 10, a plan to reorganize the various power companies along the upper Hudson River into a new corporation, to be known as the Adirondack Electric Power Corporation.

The properties proposed to be consolidated are the Hudson River Water Power Co., the Hudson River Electric Co., the Hudson River Electric Power Co., the Hudson River Power Transmission Co., the Saratoga Gas, Electric Light & Power Co., the Ballston Spa Light & Power Co., the Madison County Gas & Electric Co. and the Empire State Power Co.

OBITUARY

James McBrier, president of the Ball Engine Co., a brief notice of whose death was published in the issue of Jan. 16, was born in Allegheny, Penn., in 1835, the son of William and Mary (McMasters) McBrier.

Mr. McBrier came to Erie in 1872 and



JAMES McBRIER

engaged in the lumber business with several others, the concern turning to Erie a considerable part of the lumber output of Michigan and other lake states, in which the elder McBrier was extensively interested.

In 1887, he located permanently in Erie, and in that year he became interested in the Ball Engine Co., which was then a newly formed corporation. His business acumen, judicious management and progressive methods as president of the company quickly paved the way for the success which it has since enjoyed.

Mr. McBrier's business interests also included the lake carrying trade, and he was a most important factor in obtaining some of the national appropriations which deepened channels, enlarged locks and improved the lake waterways, which have made possible the safe navigation of the 12,000-ton carriers of today. He had held the office of vice-president of the Lake Carriers' Association and was interested in the Erie Steamship Co.

His unaffected and strong personality gained for him the greatest respect, and his active interest in municipal affairs soon identified him with many of the foremost financial and industrial interests of Pennsylvania.

Mr. McBrier was married in 1855 to Mary E. White, who survives him. Their children are David N., vice-president of the Ball Engine Co.; Frederick, secretary; Harvey L., Mary L. McBrier, and Mrs. Alexander Jarecki.

Franklin Farrel, president of the Farrel Foundry & Machine Co. since 1857, died at his home in Ansonia, Conn., on Jan. 10. Mr. Farrel's capacity for hard work often led him to toil for hours in the foundry, begrimed as were his hundreds of employees. His son, Franklin Farrel, Jr., after his graduation from Yale nine years ago, entered his father's foundry and is today one of the heads of the concern. Mr. Farrel's wealth is estimated to be between $10,000,000 and $15,000,000.

PERSONAL

F. L. Morse, treasurer and manager of the Morse Chain Co., Ithaca, N. Y., is now convalescing from a successful operation for appendicitis.

H. M. Glazier, instructor in architectural engineering, Pennsylvania State College, has resigned to accept an offer in the architectural field with a large company in Cleveland, Ohio.

John K. Bulger has been appointed supervising inspector of the United States steamboat inspection service of the first district, Pacific Coast, at San Francisco, Calif. The position carries a salary of $3000 per annum, and includes jurisdiction over both boilers and hulls. Mr. Bulger was formerly chief assistant, as inspector of boilers, to the late Capt. John Bermingham.

Joseph P. Dolan, assistant inspector of boilers at San Francisco for the service during the past 10 years, has been appointed inspector of boilers, filling the vacancy caused by the promotion of Mr. Bulger. The position pays $2250 per annum. Mr. Dolan will collaborate with O. F. Bolles, inspector of hulls, in the examination of applicants for mariners' licenses, in the investigations of accidents and violations of the boiler and navigation laws.

Moments with the Ad. Editor

Read this page, then read and answer the questions below.

We would like to know more of what POWER readers think of the ads.

All the ads in this Selling Section tell the truth.

All the ads have good points—they bring returns, and advertisers don't buy space here for any but "make-business" reasons.

But—

We have an idea some of the ads may be better than others. Some get to the average engineer better than others. Why?

At times we have thought it would be a good idea if we could take a copy of POWER, and, traveling by aeroplane, personally interview every one of the 30,000 engineers who read POWER, on the subject of that week's ads, in order to find out certain things.

For instance:

All at once in your plant, you have to have valves. POWER arrives. You rip off the wrapper, rush over to the valve ads to see whether there is a valve described there which seems right for your job.

Now you had not intended to look at any but valve ads at that time. You are in a rush. But something draws your eye to the lubricant ad or the belt ad or the grate ad across the page and causes you to read that too. Why?

You had not been thinking lubricant, belt or grate. You didn't know you needed new lubricant, belts, or grates.

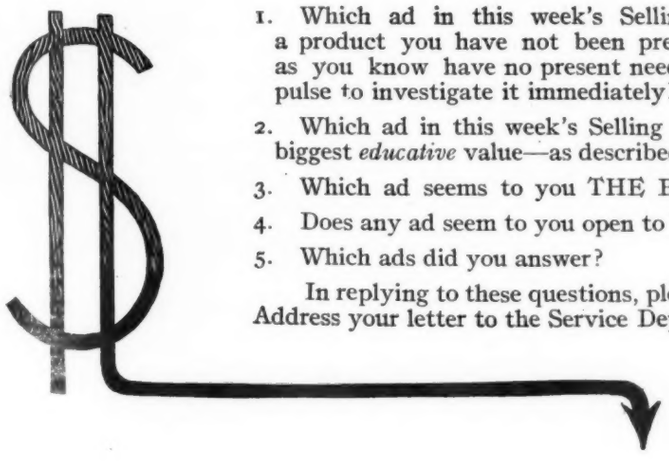
But this ad makes you feel you do need something new in that line, and you stop and take time to write for information just when you thought you were too rushed to think anything but valves!

And other ads are doing other stunts—*educating* you into the name and strong points of certain things you see advertised in POWER. You do not buy these things, or send for information, yet the ad is storing you with that idea—and when the necessity for something of this kind arises, you decide to investigate *that brand first.*

But other engineers *are* buying, sending for information, recommending and arguing for that particular product, yesterday, today, tomorrow—because the ads in POWER *have* educated them, week after week, and month after month, so that just as rapidly as their needs come, the ad operates.

Well, what kind of ads are doing *this* work best?

So, we would like the readers of POWER to reply to the following questions:



1. Which ad in this week's Selling Section of POWER, describing a product you have not been previously interested in and so far as you know have no present need for, gives you the strongest impulse to investigate it immediately? Why?
2. Which ad in this week's Selling Section seems to you to have the biggest *educative* value—as described above? Why?
3. Which ad seems to you THE BEST, inevery way? Why?
4. Does any ad seem to you open to improvement? If so, how?
5. Which ads did you answer?

In replying to these questions, please write briefly and to the point. Address your letter to the Service Department of POWER.

The best answers will be published in these columns and paid for at the regular rates.

BUSINESS ITEMS

The Busch-Sulzer Bros. Diesel Engine Co., South Side Bank Building, St. Louis, Mo., have removed their New York office from 11 Broadway to 30 Church St.

C. B. Acheson, district sales agent for the Erie City Iron Works, Erie, Penn., has removed his office to 613 Mercantile Library Building, Cincinnati, Ohio.

C. E. Beck, formerly with the Sargent Steam Meter Co., Chicago, is now agent for the De La Vergne Machine Co. (New York), at 1504 Fisher Building, Chicago.

The Hoppes Manufacturing Co., Springfield, Ohio, has removed its Pittsburg office (E. J. Deckman, representative) from the Frick Building to 1417 Oliver Building.

The Ridgway Dynamo & Engine Co., Ridgway, Penn., has opened a new district office in Pittsburg, 1417 Oliver Building. J. F. Rodgers is the local manager.

The Robb Engineering Co., Ltd., South Framingham, Mass., has made recent sales of Horizontal return-tube boilers to the Robbins, Gamewell Co., of Pittsfield, Mass., for Hotel Curtis, at Lenox; Kaolin & Clay Products Co., Vineyard Haven, Mass., and four 72-in. boilers for the Boston Y. M. C. A.

The Burt Manufacturing Co., Akron, Ohio, is sending out its 1912 catalog; which describes and illustrates the complete line of Burt oil filters, exhaust heads and ventilators. The catalog also describes the new Burt pressure oil filter, automatic fan ventilator and sliding cone damper. It is sent on request.

The American Steam Gauge & Valve Manufacturing Co., 208 Camden St., Boston, Mass., has sold American H_2O grease extracting feed water filters to the Crowell, Sherman-Stalter Co., Clyde, N. Y.; Pennsylvania Ice Co., Wilkensburg, Penn.; Webster Manufacturing Co., Superior, Wis., and to 15 other concerns in various parts of the country.

The Schaeffer & Budenberg Manufacturing Co., 963 Kent Ave., Brooklyn, N. Y., has published a new catalog on its "Columbia" recording thermometers. It contains full descriptions of the different types, gives prices and shows many illustrations of the recording thermometers and also the charts. It is mailed free to all interested in instruments of this kind.

NEW EQUIPMENT

Dorval, Que., will purchase electric-light equipment.

Kirkhaven, Minn., is to install an electric-light plant.

Brussels, Ont., will equip a new hydro-electric-power station.

The Pasadena (Calif.) Ice Co. will build an addition to its plant.

The electric-light plant at Verndale, Minn., was destroyed by fire.

Stites, Idaho, is planning the installation of a water-works system.

Fred Jensen, Hancock, Minn., contemplates installing an electric-light plant.

The San Antonio Ice Co., Ontario, Calif., will build an addition to its plant.

Fire destroyed the pump house at the plant of the Chicora Whip Co., Chicora, Penn.

The Wakonda (S. D.) Light, Power & Heating Co. is erecting an electric-power plant.

Salmon, Idaho, has voted $30,000 bonds for the construction of a water-works system.

Corning, Calif., has voted $40,000 bonds for installing a municipal water-works system.

Portsmouth, N. H., will issue $156,000 bonds for improvements to its water system.

The Arizona Copper Co. contemplates the installation of a new power plant, at Morenci, Ariz.

The Quebec Light, Heat & Power Co. will equip a 50,000-hp. plant on the Saguenay River.

The Nashville (Tenn.) Railway & Light Co. is planning to build an auxiliary power plant.

Preston, Idaho, has voted $75,000 bonds for the construction of a municipal water-works system.

The Consumers' Ice & Cold Storage Co., Brownsville, Tex., will erect a new ice and cold-storage plant.

Strathcona, Alta., will purchase a 2,000,000-gal. pumping outfit and other water-works equipment.

Monrovia, Calif., will install a water-works system to cost about $20,000. C. H. Reed, Jr., City Clerk.

Corunna, Mich., will erect a municipal electric-light plant in connection with the water-works system.

The British Columbia Electric Railway Co. will build an addition to its power house at Vancouver, B. C.

H. W. Hicks, of Verndale, Minn., contemplates installing an electric-light plant at Lake Park, Minn.

The Canton (Ohio) Cold Storage Co. has increased its capital and is planning the erection of a new plant.

Dunnville, Ont., will buy gas-engine pumps and other equipment for a new pump house to be erected shortly.

The Central Railroad of New Jersey will erect a $30,000 power house adjoining its shops at Elizabethport, N. J.

J. B. Wilson, engineer, Portland, Ore., will prepare plans for municipal water-works for the city of Montague, Calif.

The Dilwyn (Va.) Ice, Light & Preserving Co. is planning to install a five-ton ice plant and an electric-light plant.

The power plant of the Hart-Parr Co., Charles City, Iowa, was badly damaged by fire. Equipment will be replaced at once.

The Pulaski (N. Y.) Electric Light & Power Co. will extend its service, and it is said will build a new power plant in the fall.

The Board of Trustees, Tehachapi, Calif., plans the installation of an electric-lighting plant and new pumping machinery.

The Consolidated Lighting and Power Co., of Detroit, Mich., has bought the electric-light plant at Gladwin, and will enlarge same.

The Georgia Railway & Electric Co. contemplates installing additional boilers and a new turbine at the Davis St. Station, Atlanta, Ga.

C. W. Fair, of Atlantic, Iowa, has purchased a controlling interest in the Webster City (Iowa) Gas Co., and will spend $10,000 in improvements.

The Albuquerque (N. M.) Gas, Electric Light & Power Co. will spend $40,000 on improvements and additions to its gas and electric-power plants.

The main building, boiler house and storage house of the Industrial Cotton Oil Co., Houston, Tex., were destroyed by fire. Loss, about $500,000.

Plants are being prepared by W. T. Lovell, Minneapolis, Minn., for an electric-light plant and water-works system at Wayzata, Minn., to cost $35,000.

The Warner Lake Irrigation Co., Portland, Ore., is planning the erection of an electric-power plant on Upper Warner Lake. Will also install pumping plants.

The Navy Department Bureau of Supplies and Accounts, Washington, D. C., will open bids, Jan. 30, for four 300-kw. generating sets, as per Schedule No. 4249.

The Kansas Gas & Electric Co., which recently acquired the property of the Independence (Kan.) Electric Co., has purchased a site for a new large power house.

Power-plant equipment will be installed in the new $750,000 hotel to be erected on Hill St., Los Angeles, Calif., by E. P. Clark. Harris Albright, Laughlin Building, Los Angeles, is preparing plans.

The Knight Power Co., of Provo, Utah, and the Utah County Light & Power Co., of American Fork, Utah, have consolidated, and plan extensive additions. Will erect a new hydroelectric plant on the Provo River.

Power-plant equipment will be required for furnishing light and power for the new tuberculosis hospital, at Warrensville, Ohio. Information may be had of Rev. Harris R. Cooley, director of charities and correction, Cleveland.

The Todd Hydro-Electric Power Co., Tombstone, Ariz., has been incorporated with $5,000,000 capital and plans the erection of a large hydro-electric power plant, near Tombstone. Incorporators, Geo. N. Todd, Francis D. Crable, A. G. Bernard.

The Canton (Ill.) Gas & Electric Co. plans extensive improvements, including an addition to the boiler house to provide space for two 300-hp. boilers, with coal bunkers, ash conveyors, etc. Also propose installing a 750-kw. generating unit.

The Oro Electric Corporation, San Francisco, Calif., a new concern, capitalized at $10,000,000, has appropriated $7,000,000 for the erection of a 60,000-hp. hydro-electric power plant, on Yellow Creek, near Belden, Calif. This company is a subsidiary of the Oro Water, Light & Power Co.

Bids will be received until 11 a.m., Jan. 13, at the Bureau of Yards and Docks, Navy Department, Washington, D. C., for three kilowatt motor generator sets and controlling panels for the Brooklyn navy yard. Specifications can be had of the bureau or at the office of the commandant.

ENGINEERS WANTED

Under this head are published, without charge, advertisements of actual vacancies in power plants for operating engineers and assistant engineers. For the guidance of applicants for advertised positions, the advertisements must contain particulars to show the class of service demanded and the wages paid. Employers who desire to advertise under this head are requested to write for a blank form of application.

WANTED—Chief engineer for a plant in Manhattan vicinity; must be a man of executive ability, capable of taking charge of producers and gas engines, steam engines and boilers, and pumps; also to have charge of all machinery repairs in a large manufacturing plant; in replying, give experience, age, references and salary expected. Address Box 559, care Power.

HELP WANTED

Advertisements under this head are inserted for 25 cents per line. About five words make a line.

AGENTS WANTED—To sell popular steam specialty; commission basis only. Address "Rekcutaw, Post Office Box 363, New York.

SALESMAN — Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co." Power.

AGENTS for first-class steam specialty in use throughout United States. Address C. S. Wood, 410 S. 15th St., Philadelphia, Penn.

THE VULCAN SOOT CLEANER offers an exceptional opportunity for power specialty salesman Address G. L. Simonds & Co., 802 Steinway Bldg., Chicago, Ill.

CHIEF ENGINEER for new modern power plant; turbine, 800 kilowatts; 2300 volts; every convenience, shower bath; small town, southern New England; $30 per week; age, experience, references. Box 566, Power.

MANUFACTURERS' AGENTS to handle thoroughly guaranteed steam specialties; feed water heaters, steam and oil separators ,traps and exhaust pipe heads; not necessary to represent entire line of interested in only part of it; our specialties are well advertised and of good reputation. Box 569, Power.

WANTED—An experienced mine electrician who can wind armatures and keep in thorough repair, a half dozen direct current generators, a dozen locomotives, and several motors located at different mines; location a plain mining camp, on short branch in central West Virginia. Wanted, by same company, a superintendent-foreman for small mine having an output of 400 tons per day, man who can survey preferred; state age, experience fully, where obtained, in what positions, education and where obtained, married or single, teetotaler or otherwise, and salary expected. Address Box 563, Power.

SITUATIONS WANTED

Advertisements under this head are inserted for 25 cents per line. About five words make a line.

ELECTRICIAN, 5 years' experience; best of references; locate anywhere. Box 571, Power.

POSITION WANTED by a single man, 28 years old, with mining company who require service of an engineer to take charge boilers, Corliss and high speed engines, dynamos and motors and air compressors. Address Box 554, Power.

POSITION as engineer or electrician; three years' experience in power plant work; thoroughly familiar with a.c. and d.c. machines; at present employed by large electrical manufacturing company; Ohio license. Address Box 561, Power.

POSITION WANTED by engineer, two years' experience with Corliss engines and general upkeep of boilers and accessories, using my own indicator; familiar with steam shovels, traction engines, etc.; central, southern or western states preferred. Box 567, Power.

MARRIED MAN, reliable, use no liquors, would like to get steady work as engineer in country; 12 years' experience; would prefer Vermont, New Hampshire or Maine, or would like to be with contracting company as steam and gasoline engineer or pump man; have also had experience as diver on coffer-dam work, etc.; have references. Please write to C. R. Clough, 2548 So. Alder St., Philadelphia, Penn.

MISCELLANEOUS

Advertisements under this head are inserted for 25 cents per line. About five words make a line.

PATENTS SECURED—C. L. Parker, Patents, 904 G St., Washington, D. C.

WANTED — Second-hand compound Corliss engine; belted; 12x24x36; tandem or cross compound. Box 568, Power.

VOLTAGE REGULATOR wanted for 100 kw., 220 v. alternator with direct connected exciter. Tremont Worsted Co., Methuen, Mass.

EVERY ENGINEER should be posted regarding the new system of vacuum heating installed without payment of royalty; I have valuable information; write today. C. P. Monash, 1417 W. Jackson Blvd., Chicago, Ill.

MARKET YOUR INVENTION—A manufacturing firm of high commercial standing, with unexcelled manufacturing facilities, and with over sixty road salesmen, desires to take on an additional line of power plant specialties; will consider any invention that has real merit, or will confer with men interested in any mechanical device, patented or otherwise; will manufacture on royalty or purchase direct; may also utilize services of applicant. Address Box 551, Power.

ANNUAL MEETING of the stockholders of the Hill Publishing Company, for the election of directors for the ensuing year and for the transaction of such other business as may properly come before the meeting, will be held at the offices of the company, in the Hallenbeck Building, 497-505 Pearl St., Borough of Manhattan, New York City, N. Y., on Tuesday, January 30, 1912, at 12 o'clock noon.

Dated, New York City, Dec. 19, 1911.
Robert McKean, Secretary.

FOR SALE

Advertisements under this head are inserted for 25 cents per line. About five words make a line.

NEW ROBERTSON-THOMPSON indicator with planimeter reducing wheel, two pistons, six springs, etc., $65. Box 570, Power.

FOR SALE—Five Corliss vertical water leg, and sixteen Manning vertical type boilers. J. & P. Coats, Ltd., Pawtucket, R. I.

FOR SALE—Three single-phase, 133-cycle, 1100-v. alternators, 250, 120 and 70 kw., with 15-panel marble switchboard; in operation until Jan. 15. Borough of Madison, Madison, N. J.

8x10 SKINNER ENGINE, direct connected to 30-kilowatt generator, and 8x10 Allfree engine, direct connected to 20-kilowatt generator . Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

ONE PAIR of Harris Corliss engines, girder frame, approximately 300 hp. diameter of cylinder, 16 in.; length of stroke, 48 in.; diameter of flywheel, 14 ft.; width of wheel, 2 ft. 6 in.; revolutions per minute, 54; engines can be seen at the factory of the Salt's Textile Mfg. Co., Bridgeport, Conn.

FOR SALE—Three 150-hp. Manning boilers, no brick work required, 125 lb. pressure; price, $400 to 600 each; one 14-26x18-in. Harrisburg cross compound engine; splendid condition, $850; 800-hp. National feed water heater, $250; induced draft outfit with stack, suitable for 400 to 1000 hp.; price, $300. J. F. Foster, 166 Devonshire St., Boston, Mass.

ONE GENERAL ELECTRIC direct current generator, type A, 4 pole, 45 kilowatt, No. 925, 360 amperes, 850 r.p.m., 110 volt, no load; 115 volt, full load; three horizontal return tubular boilers, makers, Bigelow Co., New Haven, Conn., 20 feet long, 72 inches in diameter, 94 tubes 3½ inches diameter; two horizontal return tubular boilers, makers, Bridgeport Boiler Works, Bridgeport, Conn., 20 feet long, 72 inches diameter, 94 tubes, 3½ inches diameter; one horizontal return tubular boiler, maker, Pacific Iron Works, Bridgeport, Conn., 17 feet long, 66 inches diameter, 68 tubes, 4-inch diameter. All in good condition, 100-lb. pressure allowed on the boilers by the Boiler Insurance Co., at time of removal. Box 564, Power.

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Why not make sure that your gauges are absolutely accurate?

Test Your Gauges With An American Dead Weight Gauge Tester

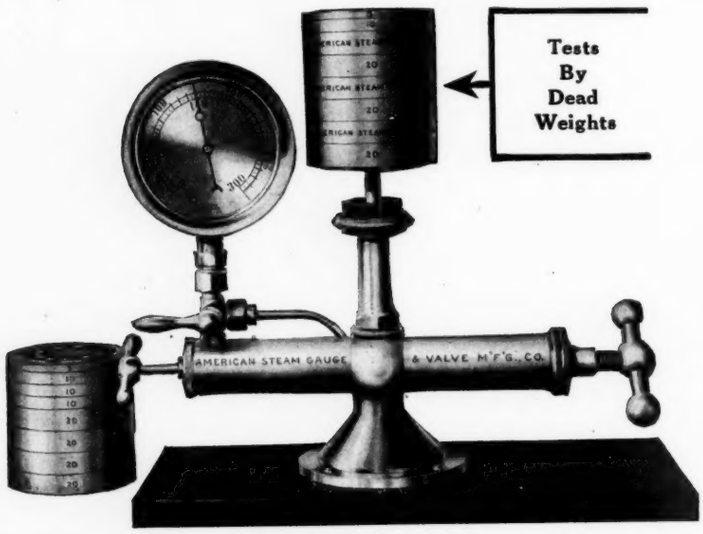
Make sure that the fireman is guided by true facts concerning the pressure on the boilers.

Inaccurate gauges always lead to wasteful firing while on the other hand accurate gauges make for economical firing. And gauges will go wrong through neglect, or carelessness, or abuse.

Test your gauges regularly with an American Dead Weight Gauge Tester.

This tester is the simplest and most compact device of its kind, more reliable than the test gauge, needs no continual repairing, has all the advantages of the mercury column.

It's a practical coal saving device that it will pay you to install. The full details are in the



Pocket Edition Of The American Catalog

Be sure to write for a copy of this catalog. It is a handy reference book on power plant devices for the modern engineer.

It describes and illustrates the whole line of American Quality Power Plant Products. It is sent on request—no charge—so write for your copy Now.

SIGN AND MAIL COUPON

American Steam Gauge & Valve Mfg. Co.
Boston, Mass. 1-23-12

Send me your complete catalog

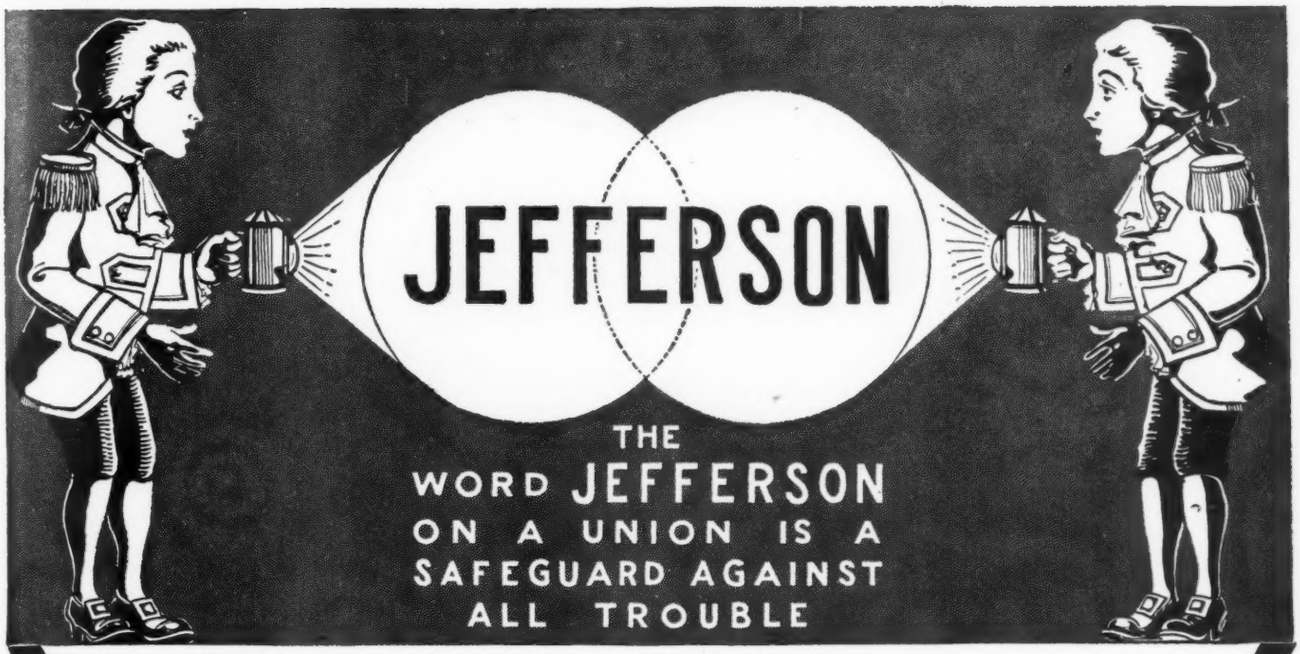
Name. . . . . .

Address. . . . . .

American Steam Gauge & Valve Mfg. Co.
Boston, Mass.

Sales Offices in New York, Chicago, San Francisco, Pittsburg, Atlanta, Montreal

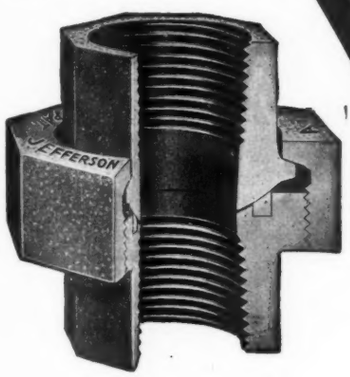
THE BEST HOUSES EVERYWHERE SELL OUR PRODUCTS



JEFFERSON UNION

The Union rightly made.
The Union with the ring of necessary brass protected from pipe-flow, so that it does not work loose from the unequal contracting and expanding of the iron and brass.
The Union with the ball-shaped shoulder.
The Union with a Joint that does not corrode.
The Union that keeps tight.
The Union that is safeguard against steam troubles

"Making good" on your job depends a lot on what you save.



Jefferson Unions help you "make good" by saving time, trouble, and cash.

Sending us this coupon below will start the process

The Jefferson Union Company

169 Main St., Lexington, Mass.

JEFFERSON UNION CO., Lexington, Mass.

Dear Sirs:—Send me a copy of Bulletin A and put my name down to receive your new book on eliminating piping troubles, when it is off the press.

Name .....

Firm Name .....

Address .....

Vol. 35. No. 4.

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Construction and adaptation of various types of instruments, including venturi meter, Pitot tube, volume and weight determinators. J. A. Knesche.
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EXAMINERS AND LICENSES:
There seems to be no general standard for conducting examinations. Some examiners pass only 22 per cent. of the applicants and with others the percentage of licenses granted runs as high as 90 per cent. for the year. Joseph King.
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USE OF EXHAUST STEAM:
Some figures on increasing the capacity of the plant by the installation of low-pressure turbines. P. Barrett Coulston.
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FUEL ECONOMY AND CO_2 RECORDERS:
A review of the subject of combustion and fuel economy and a discussion of three types of automatic CO_2 recorders. A. D. Williams.
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HOISTING ENGINE REPAIR JOB:
An interesting repair of an engine frame which had been cracked due to the effect of water in the cylinder.
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SETTING VALVES ON A CORLISS ENGINE:
The six principal operations to perform in setting the valves on a simple Corliss engine. H. P. Porter.
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SENECA RIVER BOILER TUBE BLOWOUT:
In which it is suggested that the accident may have been due to overheating caused by oil lining the inner surface of the tube.
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DESIGNING A BEARING:
Outline of method and computations for a definite case. Prof. R. C. H. Heck.
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CAST IRON HEAD BLOWN OUT OF STEAM DOME:
A boiler 32 years old and located under the sidewalk suddenly gives way and causes considerable property damage. It was allowed a working pressure of 80 lb.
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OLD RELIABLE STEAM TO THE RESCUE—UNDER DIFFICULTIES:
An incident illustrating the advantage of having a steam plant to supplement water power. R. C. Turner.
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POLARITY OF THE COOPER HEWITT LAMP:
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UNBALANCED AIRGAPS AND BEARING WEAR:
R. A. Cultra. Page 115

A QUICK REPAIR OF A RHEOSTAT:
Earl Pagett. Page 115

A SUCCESSFUL PEAT GAS POWER PLANT IN IRELAND:
A Crossley installation of 400 hp. capacity replaces a Mond-gas plant with a large saving in the annual fuel bill.
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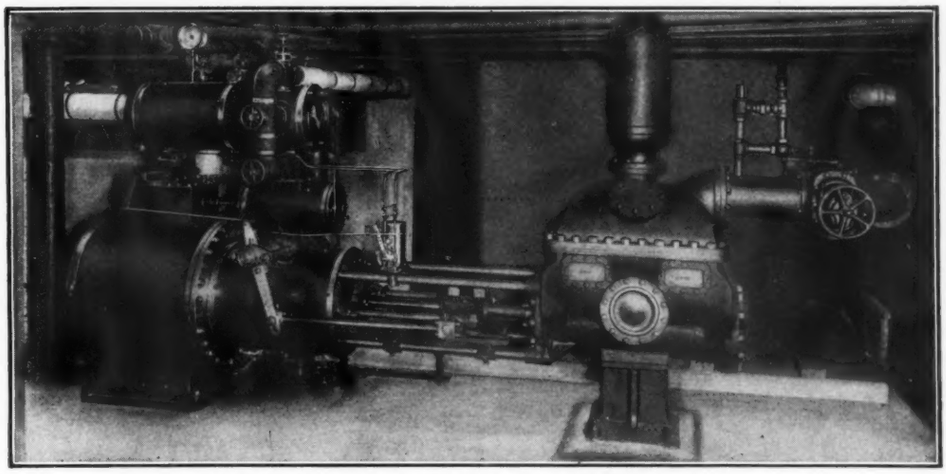

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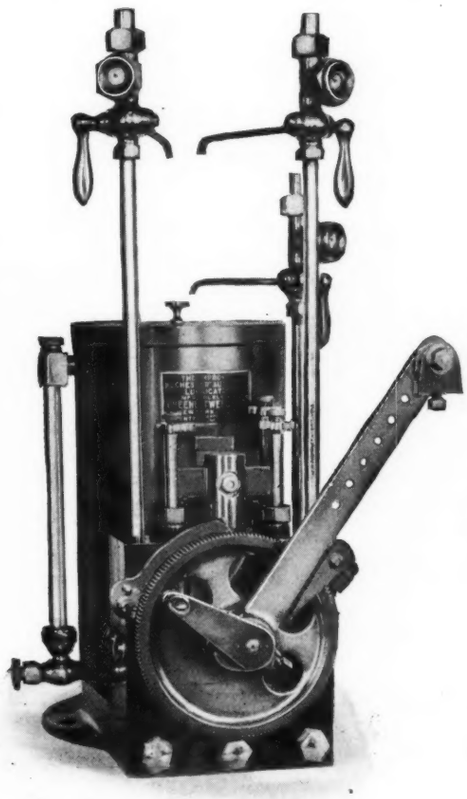

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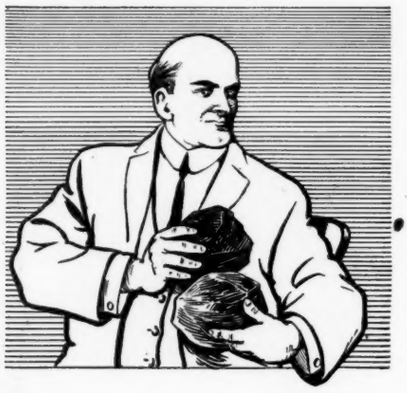

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